MANAGEMENT HANDBOOK

To Aid Emergency Expansion of

Dehydration Facilities for Vegetables and Fruits

Prepared at the Request of

Office of the Quartermaster General

Department of the Army

Washington, D. C.

By

Western Utilization Research and Development Division

Agricultural Research Service

U. S. Department of Agriculture

Albany - California

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PREFACE

This Management Handbook was prepared at the request of the Office of the Quartermaster General. The Handbook is intended to serve as a quick reference source for basic information in case a rapid expansion of vegetable and fruit dehydration becomes necessary to supply the increased needs of the Government in a national emergency.

It is recognized that the present dehydration industry would be in the best position to carry out the initial expansion. If even greater production is needed than present companies are able to supply, new producers may be brought into the picture. The Handbook is designed to guide newcomers into a proper and thorough investigation of factors that must be considered before a decision is reached to build or buy a plant. Established firms may find the Handbook of value to new technical and management employees.

Preparation of this Handbook was the responsibility of the staff of Industrial Analysis Investigations of the Engineering and Development Laboratory, Western Utilization Research and Development Division.

CHAPTER I

MILITARY USE OF DEHYDRATED FOODS

Production of Dehydrated Vegetables and Fruits

A. Dehydrated Vegetables

The production of dehydrated vegetables has varied markedly over the past 40 years, mainly because of the effects of two World Wars. Production for representative years is shown in Table I. The source of data is the "Statistical Review and Yearbook" of Western Canner and Packer. No data on production have been published for years since 1951.

TABLE I

Estimated Total Production of Dehydrated Vegetables in the United States

(millions of pounds)

1919	10.3	1941	13.2	1947	50.7
1925	1.3	1942	53.8	1948	179.5
1935	1.6	1943	125.5	1949	68.6
1937	1.5	1944	208.7	1950	60.0
1939	5.6	1945	130.3	1951	50.0
1940	5.4	1946	54.2		

The relatively large production in 1919 dropped to a peace-time demand of about 1.5 million pounds a year. Production increased in 1939 to over 5 million pounds and continued until it reached a record of over 200 million pounds in 1944. It again decreased after World War II. In 1948 a large quantity of potatoes was dehydrated which was sent overseas as foreign aid. Production of dehydrated vegetables is shown by types in Table II. Table III shows States in which the Government procured dehydrated vegetables during the first part of World War II.

TABLE II

Estimated Total U.S. Dehydrated Vegetable Packs, 1941 to 1950 Inclusive

(millions of pounds)

Year	Beets	Cabbage	Carrots	Garlic	Onions	Peppers	Potatoes	Sweet-potatoes	Ruta-bagas	Tomatoes	All Others	Total
1941	a/	a/	0.1	1.0	3.8	5.7	2.0	0.1	---	a/	0.5[a/]	13.2
1942	1.0	1.0	7.5	1.5	7.5	7.8	20.0	5.0	a/	a/	2.5[a/]	53.8
1943	3.4	3.7	20.4	2.0	9.4	4.4	71.0	7.2	1.0	1.0	2.0	125.5
1944	6.8	7.3	13.7	2.0	18.8	5.1	132.0	13.7	1.8	2.5	5.0	208.7
1945	5.0	5.0	7.0	2.0	10.0	7.3	75.0	15.0	a/	1.0	3.0[a/]	130.3
1946	a/	a/	2.0	2.0	10.0	17.2	20.0	2.0	---	a/	1.0[a/]	54.2
1947	a/	a/	a/	1.5	6.0	6.1	35.0	a/	---	a/	2.1[a/]	50.7
1948	a/	a/	a/	1.5	6.0	5.5	165.0	a/	---	a/	1.5[a/]	179.5
1949	a/	a/	a/	b/	8.0[b/]	8.6	50.0	a/	---	a/	2.0[a/]	68.6
1950	a/	a/	a/	b/	9.0[b/]	7.8	40.0	a/	---	a/	3.2[a/]	60.0

a/ Items combined under "All Others".

b/ Garlic combined with onions.

Source: Western Canner and Packer, Statistical Review and Yearbook issues.

TABLE III

Principal Sources of Government Procurement of Dehydrated Vegetables (1941 through First Half of 1943) 1/ 2/

	Beets	Cabbage	Carrots	Onions	White Potatoes
California	---	89.9%	95.5%	86.3%	7.8%
Idaho	---	---	---	11.0%	55.0%
Maine	---	---	---	---	9.5%
New York	67.0%	9.7%	4.3%	---	4.9%
New Jersey	30.0%	---	---	---	---
Oregon	2.5%	---	---	---	---
Washington	---	---	---	---	10.0%

1/ "Proceedings of the Maryland Dehydration Conference", p 19, University of Maryland, May 12 - 14, 1943

2/ Sweetpotatoes were processed in the Southern States; most of other vegetables (not listed) were processed in California

B. Dehydrated Fruits

Dried or evaporated apples, averaging 24% moisture content, have been an important commodity on the civilian market for many years. During World War II (1941-1945) between 5% and 8% of the total commercial apple crop was dried each year, with the Military taking an average of 43% of the total output of the dried product. A substantial portion of these Military purchases was a low-moisture product containing about 3% water. More detailed information concerning the War period production of dried apple products is given in Table IV.

The production of dehydrated cranberries (a product containing 5% to 10% moisture) was a new industry at the beginning of the War and expanded to meet the needs of the Military. During the five War years over 14% of all cranberries grown was dehydrated -- approximately the same percentage of the total production that was canned. It is understood that all of the dehydrated product went to the Military. Additional information concerning cranberry production during 1941-1945 is given in Table IV.

TABLE IV

Approximate Production of Dried Apples and Cranberries During World War II 1/

Year	Total Commercial Crop in U.S. (M Tons) (fresh)	Dried (M Tons) (fresh)	Dried (M Tons) (processed product)	Dried Purchased by U.S. Military (M Lbs.) (processed product)
		Apples	Based on 24% Moisture Content	
1941	2,933	148	34,000	9,000
1942	3,041	177	42,000	28,800
1943	2,095	161	35,000	11,700
1944	2,910	168	34,000	17,300
1945	1,603	112	29,000	8,200
		Cranberries	5% - 10% Moisture Content 2/	
1941	36	2.5	500	
1942	41	9.3	1,900	
1943	34	6.4	1,300	
1944	19	3.1	600	
1945	33	2.2	400	

1/ Computed from data given in U.S.D.A. "Agricultural Statistics", pp 179, 183, 205, 233 (1950); and National Canners Association "Canned Food Pack", 1945

2/ Assumed that all these products purchased by U.S. Military

Markets For The Products

Depending upon foreign and domestic conditions the prospective dehydrator will have three markets to consider: (1) Military agencies of the Government, which take a large quantity of dehydrated vegetables and fruits in times of national emergencies; (2) other Government agencies, and (3) the civilian market.

Military Market. The needs of the Military agencies of the Government for dehydrated vegetables and fruits have varied tremendously over the past years. Purchases in 1951 were only a small fraction of the quantity bought during the last year of World War II. Future procurements depend upon conditions yet to be determined. The potential scope of Military procurements might be indicated from an analysis of World War II requirements.

After several years of experience in procurement under wartime conditions, the Military agencies estimated their requirements for the 1945-46 fiscal year as follows (as reported in the Fourth Annual Meeting of the National Dehydrators Association, Chicago, Illinois, February 6, 1945):

(In Millions of Pounds)

Potatoes	134.0	Carrots	6.5
Sweetpotatoes	19.4	Beets	4.9
Onions	12.7	Rutabagas	0.6
Cabbage	8.7	Apples (low moisture)	10.4
		Cranberries	1.8

When the War ended in 1945, production of dehydrated vegetables and fruits for the Armed Forces was reduced and these estimates were never realized. Current Military requirements consist primarily of dehydrated potatoes (granules and dice), onions, and apples. The desirability and acceptability of the various dehydrated products are continuously under study, and future Military procurements will largely depend upon results of these studies.

Other Government Markets. During World War II, large quantities of dehydrated vegetables were purchased by the War Food Administration for shipment overseas to our allies. The demand is indicated by the following tabulation of estimated requirements for the fiscal year 1945-46 (as reported in the Proceedings of the Fourth Annual Meeting of the National Dehydrators Association, Chicago, Illinois, February 6, 1945):

(In Millions of Pounds)

Potatoes	30.5	Tomato flakes	4.0
Onion flakes and powder	10.2	Beets	2.8
Carrots	6.8	Garlic powder	2.0
Cabbage	5.3	Rutabagas	1.8

In the years following World War II, considerable quantities of potato flour were prepared and shipped abroad. The potatoes used were purchased by the Government as a means of supporting the prices of fresh potatoes. While such support and use of potatoes or other vegetables may be carried on in the future, dehydrators can not rely on this market.

Non-Military governmental purchases are likely to be covered by tentative Specifications (issued by the U. S. Department of Agriculture) or by Federal Specifications (issued by General Services Administration). If and when the Government plans to purchase for either domestic use or foreign aid, information about such plans and the Specifications that would be involved should be available from the U. S. Department of Agriculture, Washington 25, D. C.

Civilian Market. Dehydrated vegetables and fruits are manufactured for sale in the retail, remanufacturing, and institutional civilian markets. Retail items include mainly potato products (granules, flakes), soup mixes, flaked and powdered seasonings (onions, peppers, garlic), and health-food and camping items. Large quantities of dehydrated vegetables are used in the remanufacturing trade. Dried meat extracts and other materials are mixed with various vegetables such as carrots, peas, parsley, celery, potatoes, onions, peppers, and garlic to make the packaged soup mixes sold in retail stores. Dehydrated diced potatoes are used in the manufacture of canned items such as hash. Dehydrated onions, peppers, garlic, and celery are used in piece or powder form in the manufacture of chili sauce, catsup, pickles, relishes, and related products. Many institutional users buy dehydrated foods for serving in meals. Potato products such as granules and flakes are important in this use.

In 1951 the vegetable dehydration industry produced an estimated 50 million pounds of dry products, 60 percent of which was dehydrated potato. The remaining 40 percent consisted of 9 million pounds of onions and garlic, 8 million pounds of peppers, and about 3 million pounds of other products. These figures include Military and other Governmental purchases as well as purchases by the civilian market. While less than half of the total production, or about 20 million pounds, went to the civilian market, this amount does represent a notable increase in civilian consumption over the approximate 5 million pounds produced in 1940.

No data are currently published on the production of dehydrated vegetables and fruits. It is obvious, however, that production is increasing. New plants have been built and existing plants expanded. The greatest increase has been in potato products, mainly granules and flakes. The rapid technologic development that has occurred in the dehydration industry since World War II is responsible for the recent expansion and will doubtless contribute to even further growth.

How Production Was Accomplished During World War II

The rapid increase in dehydration in World War II was accomplished in three ways:

1) Converting established processing plants

2) Building additional capacity in existing plants by moving and converting previously used equipment

3) Building entirely new plants

The war-time expansion was carried out partially by experienced processors, but in addition, many inexperienced newcomers were attracted to this industry. The costliness of inexperience was illustrated many times in:

1) Slow, costly "learning periods" before acceptable products could be produced

2) Variable quality and erratic output of products

3) Production costs too high to operate on a competitive basis with other plants

By the mid-point of the War, 44% of the dehydration plants then operating were those that had been converted from other methods of processing. Half of the 93 white potato dehydrating plants were new, as were 14 of the 24 sweetpotato plants. The dehydration of other vegetables was done mostly in either converted plants or in existing plants. 1/

By the end of the War, the management and operation of dehydration plants followed this pattern: 2/

1) 35% by people whose principal business was the operation of dehydrators

2) 52% by other food processors and manufacturers

3) 7% by shippers of fresh fruit and vegetables

The building of new dehydrators and the conversion of old plants were done solely to fill Government orders during war-time, and yet financing for this purpose was largely by private capital. For some, loans from Federal agencies supplied the money needed, but the total of these loans came to only about 10% of the total spent for such purposes. Although the Government made only limited loans for operating capital needs (about twice the amount of money loaned for fixed capital), the plants nevertheless received considerable financial assistance by virtue of having Government contracts for their products. 3/

1/ Cf. pp. 28-29 of Post-War Readjustments in Processing and Marketing issued (processed) May 1945 by the U. S. Department of Agriculture Inter-Bureau Committee on Post-War Planning.

2/ Cf. P. 28 and 30 of Post-War Readjustments... cited above.

3/ Cf. p. 63 of Post-War Readjustments... cited above, and p. 9 Proceedings of the Dehydration Meeting, University of California, Berkeley, September 15, 1950, sponsored by the Associates, Food and Container Institute.

Military Preferences For Dehydrated Vegetables and Fruits

A. Dehydrated Items Used During World War II

The Quartermaster Corps has made comprehensive studies regarding World War II food preferences of the American soldiers. The Quartermaster's conclusions may be summarized as follows: 1/

FIRST PREFERENCE: Onions; sliced cranberries; apples (very low moisture)

SECOND PREFERENCE: White potatoes; sweetpotatoes

THIRD PREFERENCE: Beets; carrots; cabbage

These findings will doubtless influence the formulation of plans for meeting the needs in any emergency.

1) Vegetables

The experience with dehydrated vegetables in World War II pointed to certain general conclusions concerning specific items: 2/

a) Dehydrated white potatoes --- This item typified the convenience aspect of dehydrated products. Its edible qualities were quite acceptable. For these reasons it may continue to be the most important dehydrated food in satisfying the requirements of the Armed Forces.

b) Dehydrated onions --- The demands for a flavoring ingredient were satisfied by this product. It was a well-liked item.

c) Dehydrated sweetpotatoes --- This item has very high nutritive values. It apparently has important potentialities in any national emergency food program, provided its storage stability and acceptability can be improved sufficiently.

d) Dehydrated cabbage --- This product puts stringent requirements on packaging to preserve the desired qualities. Cabbage -- either fresh or dehydrated -- was not a popular food in the Armed Forces of the recent war and was used chiefly for its nutritive value.

e) Dehydrated carrots --- Carrots, relatively easy to dehydrate, were over-produced during World War II. This item was similar to cabbage in requiring special packaging for proper preservation. It was unfortunate from a nutritional standpoint that dehydrated carrots were not well liked.

f) Dehydrated beets --- This had never been a popular food with the Armed Forces and its future Military use was reported as not promising.

1/ Cf. p. 63 of Post-War Readjustments... previously cited, as well as Proceedings of the Dehydration Meeting, University of California, Berkeley, September 15, 1950...

2/ Cf. pp. 69-71 of Post-War Readjustments... cited above.

2) Fruits 1/

The World War II Military experience and the post-war civilian outlets for dried and dehydrated fruits indicated these general conclusions:

a) Dehydrated apples -- Ordinary dried apples do not have the storage life desired for Military purposes, but the low-moisture dehydrated products obtained during World War II satisfied the requirements for both storage stability and palatability. In fact, this item was considered one of the best dehydrated products used by the Armed Forces, and is expected to be in considerable demand for any national preparedness program.

b) Dehydrated cranberries --- Military experience with dehydrated cranberries was quite favorable in World War II. This item enjoyed high consumer acceptance, and proved to have fair stability in storage. This product should be in good demand for future Military use.

B. Other Dehydrated Vegetables and Fruits That Show Promise as Reported by The Quartermaster Corps

Extensive research and development programs have resulted in new products or new uses for old products that appear to have excellent potential in future Military feeding programs. Some of the products are still in the experimental stage of development; others have been field tested but not purchased in appreciable quantities; and others are being produced as standard items.

1) Vegetables

a) Dehydrated green peas --- This item is an exceptionally well-liked item in its fresh, frozen, or canned forms, and has shown similar acceptability in the dehydrated form, providing the correct quality of raw material is used in its production.

b) Dehydrated, pre-cooked, red beans --- This item is a recently developed product which typifies the new feeding concept of rapid rehydration through the mere addition of hot water for preparing and serving. The critical factor in processing is the dehydration step in which the product either must enter the dehydrator in the frozen state or the initial dehydration must be conducted under high humidity conditions.

c) Dehydrated sweet corn --- Sweet corn is one of the most highly acceptable vegetables on the American diet. The dehydrated product has shown similar acceptance; however, the packaging of the product is critical requiring low moisture and low oxygen levels.

1/ Based upon information supplied by: (a) California Crop & Livestock Reporting Service, Bureau of Agricultural Economics, U.S.D.A., (b) Agricultural Statistics 1950, U.S.D.A., and (c) an industrial specialist (who was a member of the Quartermaster Corps dehydrated food procurement group during World War II).

d) Dehydrated green beans --- Studies on this product have shown that it has exceptional stability and acceptance even at high temperature storage and hence, should play an important part in the future feeding of the Armed Forces.

e) Dehydrated, pre-cooked, Navy beans --- This item is a recently developed product which typifies the new feeding concept of rapid rehydration through the mere addition of hot water for preparing and serving. The critical factor in processing is the dehydration step in which the product either must enter the dehydrator in the frozen state or the initial dehydration must be conducted under high humidity conditions. In processing of this product it is essential that enzyme inactivation of the raw (dried) beans be effected prior to soaking in order to provide adequate storage stability in the finished dehydrated product.

f) Dehydrated, pre-cooked, white potato dice --- This form of potato is mainly important in its application to rapidly prepared menu items such as potato hash and therefore, should prove quite important in the future feeding concept of the Armed Forces.

g) Dehydrated, pre-cooked, sweetpotato dice --- The high nutritive value of these items should make these products of great importance in any national emergency. The storage stability and acceptability were low during World War II; however, subsequent research work has shown that variety, preprocessing, and packaging treatments are critical to obtaining the required stability. These factors are now fairly well established and the product should prove more important in the future feeding system of the Services.

h) Dehydrated, pre-cooked, green lima beans --- Processing of the product is similar to that for Navy and red beans, except for the raw material which is either fresh or fresh frozen greem lima beans. The product has good stability and is mainly a convenience item.

i) Dehydrated spinach --- Although spinach is not a highly accepted item the convenience and its use to provide menu variety should make the item important in feeding.

j) Dehydrated green peppers --- This form of pepper is presently in wide use as a garnish and is an ingredient in canned foods.

k) Dehydrated garlic --- This product satisfies the demand for a flavoring ingredient in the food industry and has continued to expand in the post-war periods.

2) Fruits

a) Dehydrated cranberries (sauce) --- This product has a high acceptance and stability. The most critical factor which hampered stability was the gelling power. This has been found to be dependent on moisture content with 4% as the critical level.

b) Dehydrated grape juice --- This product is prepared by the simple concentration to a molten concentrate to which grape essence is added, the product chilled and ground for packaging and use. The product has exceptionally good stability and flavor.

c) Dehydrated apple juice --- This product is prepared by the simple concentration to a molten concentrate to which apple essence is added, the product chilled and ground for packaging and use. The product has exceptionally good stability and flavor.

d) Dehydrated pineapple juice --- This is not a completely developed product; however, its production is expected to be similar to that of orange juice. The mention of this product is made mainly because of its future potential use as a convenience fruit juice item.

e) Dehydrated pineapple --- This item is mentioned not because of its stage of development, but because there is a need for this product in the feeding of the Military, and because it appears feasible to vacuum-process the product in the near future.

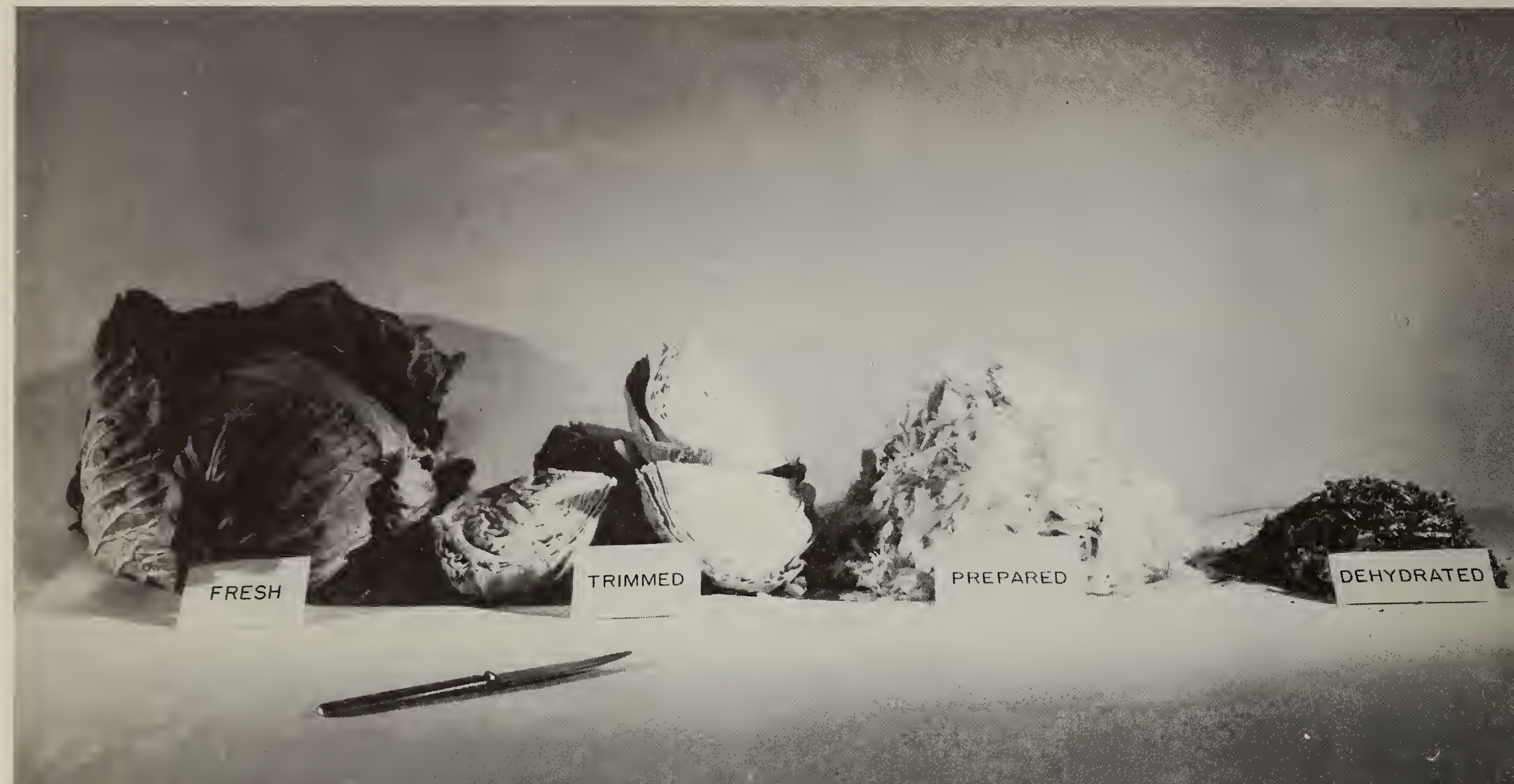
f) Dehydrated orange juice --- A product which has great possibilities for extensive use because of its good flavor and long storage life compared to its canned counterpart. The product must be desiccated to less than 1% moisture for stability.

g) Dehydrated grapefruit juice --- A product which has great possibilities for extensive use because of its good flavor and long storage life compared to its canned counterpart. The product must be desiccated to less than 1% moisture for stability.

h) Dehydrated fruit mix --- This product is prepared from a mixture of low moisture dehydrated fruits. Its application is mainly for use as a stewed fruit product or in a fruit pie. Other mixes of fruit as cocktail mixes are being developed, and should be equally desirable due to their convenience and stability aspects.

i) Dehydrated applesauce --- Another convenience item which has good stability and flavor, and which again has the weight and space saving factors found in most dehydrated items.

j) Dehydrated tomato juice --- This product is one of extreme importance to the Military because of the tremendous space and weight saving potential, but even more important for the greater stability offered over other canned tomato products (e.g. paste, puree, juice). The simplification of supply through its use as a substitute for these other forms of products is highly important to the Military.



"A comparison of fresh, trimmed, prepared, and dehydrated cabbage."

"A graphic illustration of the great reduction in space gained through dehydration. The truck-trailer load of fresh cabbage, when dehydrated, will be reduced to the 'Jeep' load shown in the foreground."

(Courtesy of Western Canner & Packer and Cal-Compack Foods, Inc.)

CHAPTER II

PRINCIPLES OF DEHYDRATION

Definition of Dehydration

Dehydration, broadly defined, means removal or loss of water from some material. Rate and extent of dehydration are affected by many factors.

Drying is done by artificially produced heat under controlled conditions. With ideal conditions of dehydration, practically all the water content of many vegetables and fruits may be removed with little impairment of their nutritive values and palatability.

The essential operations and principles involved in dehydrating vegetables and fruits are given in the following sections.

Major Manufacturing Steps

Information given below is of a general nature largely applicable to most kinds of dehydrated vegetables and fruits. The reader should also study the detailed information given elsewhere in this Handbook. The classification code used follows the system outlined in Appendix H.

100. RAW MATERIAL PROCUREMENT

The fundamental requirement for operating any dehydration plant is a plentiful supply of suitable raw material at a reasonable price. A plentiful supply can only be assured for year after year operation through proper planning. The commodity must be of proper variety, maturity, and condition for dehydration purposes. General information concerning procurement of raw material to meet the needs of emergency plants is given in Chapter VI. More specific information and requirements are outlined in Chapter VIII.

Harvesting, initial handling, transporting, and storing of fresh vegetables and fruits must be properly done to produce satisfactory dehydrated products. The methods to be used and the requirements for each of these operations must be clearly defined and understood by grower and plant operator. In this way each can help to maintain the fresh material in proper condition until it is processed.

All fresh products, both in bulk and in containers, must be shipped and stored so as to prevent bruising and other damage. Ample provision must be made for keeping them cool, ventilated, and protected against wilting, microbial spoilage, and damage from dust, fumes, moisture, insects, and rodents. The use of properly controlled refrigeration, humidity, and ventilation will lengthen the permissible time between harvesting and processing.

Some raw materials for products considered in this Handbook are in some stage of processing when received at the dehydration plant. Citrus concentrates, green peas, and green beans may be frozen when received, and these are held in frozen storage until needed for dehydrating. Low moisture apples, 2.5% water, are normally made from dried apples containing up to 25% water. Dried apples have appreciable storage stability and may be held for several months at normal temperatures.

200. MANUFACTURING OPERATIONS

210. Raw Material Handling in Plant

Raw materials are inspected and undersized, culls, stems, and other undesirable items removed. Classifying according to size may be necessary, especially if the raw material is peeled or cored on some types of equipment. Segregation according to types or lots of raw material may also be advisable.

220-230. Preparing for Drying

A. Washing

The first processing step usually is removal of dirt and foreign materials. Root-type products (such as potatoes, carrots, and onions) may be passed first over a dry washer to remove loose dirt and trash. Washing is the major cleaning operation and may be done in several steps, depending on the commodity and type of contamination. Initial washing may consist of tank-soaking, spray-washing, or fluming the raw material. Additional washing may be done on belts, in rotary drums, or in shaker washers. In some cases washing is done after the raw material has been trimmed and/or cut.

B. Peeling

Present Specifications used by the Military require peeling of root-type commodities. It is important that peeling be done effectively and with minimum loss of edible material.

There are numerous methods of root peeling: lye, steam, flame, abrasive, and manual. Steam and lye peelers usually give positive and uniform peeling results and will handle a wide variety of products. Flame peelers are used on onions.

For leafy-type vegetables, such as cabbage, outer leaves are removed as they usually carry an appreciable amount of dirt, may be damaged, or are undesirable for other reasons.

C. <u>Trimming, coring, rooting, and topping</u>

After being peeled, the material is manually trimmed for removal of undesirable portions such as discolored or damaged areas, "eyes" and deformities, and any remaining skin and stems.

Some vegetables, such as onions and cabbage, are cored. Apples are peeled and cored.

D. <u>Cutting</u>

The trimmed material is then cut into pieces of desired shape and size for cooking or drying. The smaller the piece, the faster cooking or drying can be accomplished. Undersized small pieces produced by the cutting operation should be removed.

E. <u>Blanching, cooking, sulfiting, and/or starch coating</u>

Immediately after the foregoing preparation steps, most vegetables, (notable exceptions are onions and garlic) are given a blanching or scalding treatment. This consists of heating the pieces for a short time at a high temperature in steam, or sometimes in boiling water. The treatment is done in continuous or batchwise operation, and accomplishes four objectives:

1) Enzymes which cause discoloration of products prior to drying are largely inactivated by blanching

2) In subsequent operations or storage of the finished product, blanching prevents or retards undesirable color, odor, and flavor changes, and loss of vitamins and other nutrients

3) Blanched commodities usually dry faster than unblanched ones

4) Blanched products rehydrate quickly and more completely and make possible cooked products having better texture and flavor

Steam blanching (most commonly used method in the United States) results in less leaching of nutritive components than water blanching. With the latter method, however, uniform blanching is somewhat easier to attain.

Sulfiting of dried fruits has been an accepted practice for many years. The treatment consists of exposing fruit pieces to the fumes of burning sulfur (sulfur dioxide) prior to, during, and/or after the drying stage, or applying sulfite solutions to pieces prior to the drying operation.

Sulfiting of vegetables, however, was not advocated in this country until after the United States entered World War II. During the early part of the war period, the beneficial effects of sulfiting dehydrated cabbage were established and accepted. Since then sulfiting has been shown to be of value for such dehydrated products as potatoes, carrots, sweetpotatoes, green peas, and green beans. Vegetables are usually sulfited by being sprayed with a solution containing sulfite and bisulfite salts.

Sulfiting retards color changes in the commodity during the drying process and during subsequent storage, and tends to prevent development of off-flavors. It helps protect carotene and ascorbic acid but has a deleterious effect on thiamine. Sulfiting permits use of higher drying temperatures, thus shortening drying time.

Sulfiting must be controlled carefully to attain the desired stabilizing effects and at the same time to avoid off-flavors caused by presence of too much sulfite.

No sulfiting is done if the products are intended for use as ingredients in canned foods because of off-flavors that may develop in the canned products, increased corrosion on the inside of the cans, and the labeling problem if the canned product is sold in civilian markets.

Starch coating has been found to help carrots retain their color and vitamin content. The pieces are treated with a 2.5% starch solution after blanching. Starch coating may be beneficial for other vegetables, but such usage has not been established. (NOTE: At present, starch coating for dehydrated vegetables or fruits is not specified or permitted by the Military)

F. Pureeing, mashing, granulating, or mixing

In the production of potato granules, sliced potatoes are cooked in steam, and then comminuted by crushing, extruding, or whipping. In the production of powdered dehydrated cranberries, whole berries are cooked and then macerated in a pulper.

240. Drying

Some fundamental factors involved in the design of drying systems for vegetable and fruit products include availability of water that is to be evaporated, heat requirements to change water to vapor, removal of water vapor from the drying system, and handling of product during drying operation.

A. Availability of water that is to be evaporated

Drying is usually a surface phenomenon. Moisture in the material being dried is at an exposed surface when evaporation occurs. During the initial stage of drying most vegetables and fruits, water is readily available at the surface. During this period water is evaporated rapidly. As drying progresses and water at the surface is evaporated, water in the interior of the piece must diffuse to the surface before drying can continue. As water content of the material is lowered, the rate at which water can move to the surface becomes slower. At some point in the drying process the diffusion rate becomes slower than the rate at which moisture can be evaporated at the surface. Rate of evaporation continually decreases for the remainder of the drying operation.

Piece size of the material being dried affects the drying rate. Surface area from which evaporation may occur increases as piece size decreases, and the distance that moisture in the center of the piece has to diffuse is shortened. Piece shape (i.e. cube, strip, slice, etc.) also affects these same factors. In the drying of liquid products, such as citrus concentrates, surface area may be increased and diffusion distance to the evaporation surface decreased by puffing the product so that it exists as a foam with many bubbles having thin walls.

The change in availability of water changes the rate at which it can be evaporated. On this account the drying operation can be divided into stages. Commercial equipment and processes have been specifically designed for the various stages. One common division of the drying process has been to have primary, secondary, and finish drying stages. The primary stage is in the initial period when most of the material is still in the rapid drying rate period when water is readily available at the surfaces. Equipment is designed for high heat input and removal of large quantities of water vapor from relatively small quantities of material on the drying surface.

The secondary drying stage starts while some of the material is still in the rapid drying rate period and extends well into the falling rate perio when diffusion from the interior of pieces controls the drying that can be attained. The equipment for this stage may be similar to that used for primary drying but with lower heating and vapor removal capacities.

Finish drying is confined to the low end of the falling rate drying perio Heat input and vapor removal are relatively small compared with either th primary or secondary stages, and large quantities of material are held in the finish dryer for considerable lengths of time.

If extremely low moisture is desired, in-package desiccation may be used. In this operation the product is continuously exposed to drying condition for its entire shelf life. A bag containing a desiccant material, such as a calcined lime, is placed in the packaging container with the product The moisture transfers slowly from the product to the desiccant, usually taking weeks for a moisture loss of 1 or 2%.

B. Heat requirements to change water to vapor

In the drying processes that are considered in this Handbook, water in the product being dried exists as a liquid and is changed to a vapor during drying operation. Heat required to evaporate one pound of water is approximately 1000 B.T.U., varying somewhat with the temperature at which evaporation occurs. The product may receive this heat from hot gases surrounding the product, by radiation from heated surfaces, or by contact with heated surfaces. Hot air is the most commonly used heating medium.

Heat input must cover other requirements in addition to evaporation. Temperature of the product rises during drying. Some heat is lost by radiation and conduction. Water vapor leaving the drying system is at a higher temperature than water in the entering product. If the product is being dried in air, temperature of this air leaving the system is above outside air temperature. All of these factors represent heat losses. Heat efficiency of dryers commonly falls between 30 and 70%. In most drying systems the higher the temperature the higher the efficiency will be.

Permissible drying temperature must be below that which will cause product damage. The temperature used varies with the stage of drying for each commodity and even between different lots of the same commodity. It also varies with rate of drying, type of dryer being used, and other factors. Drying temperatures are best determined by plant runs and adjusted to meet specific requirements for the material being dried.

C. Removal of water vapor from the drying system

In order that the drying operation may proceed, it is necessary that the water vapor be removed from the system. Two methods may be used; passing air around the product to sweep out water vapor, or pumping out water vapor so that a vacuum is created around the product.

The amount of water vapor that can be removed by a given quantity of air is limited, being primarily a function of air temperature. If the full capacity of the air is approached, the drying rate becomes very slow. A compromise is used in design of equipment so that a satisfactory drying rate can be attained but without use of an excessive quantity of air.

In vacuum drying the difficulty of pumping depends on the vacuum that is used. At low pressure, expansion of water vapor is great, and equipment for handling this water vapor must be large.

D. Handling of product during drying operation

The characteristics of the raw material determine the methods by which it may be handled during drying, although some methods are adaptable for a wide range of products.

Piece form products are spread over surfaces such as trays or belts for drying. The loading depth may vary from one layer of pieces to several feet of product depending on durability of the material, drying rate to be attained, type of air flow, and other factors. Some materials are too soft to be handled in depth and are customarily dried in a single layer on trays. Loadings for firmer products, such as cut vegetables and apple slices, vary in depth. If flow of air is across the product, loadings are relatively light, ranging from 1 to 4 pounds per square foot. If air flow is through the product bed, loadings are heavier. For initial drying they may range from 10 to 20 pounds per square foot (3 to 6 inches). For final drying in bins, where the drying rate is slow, depths of 3 to 5 feet are permissible.

Granular or powdered materials are commonly dried while suspended in heated air streams. Velocity of air must be sufficient to carry the larger size particles. Maximum velocity may be limited by impact damage to the particles when they strike the dryer walls.

Liquid materials may be handled somewhat similarly to solid materials. The more viscous liquids are spread on trays or belts; the less viscous are sprayed into heated air streams.

Drying may be carried out in various adaptations of continuous or batch operations, both being used commercially. The specific methods influence permissible drying temperatures, air velocities, and drying rates for each product, which in turn affect the product quality. Various drying methods are discussed in detail in Chapter X.

250. Product Finishing

After the drying steps, further operations are required before product is packaged. Fines must be removed from some products in order to meet purchase Specifications. All piece-form products should be inspected for removal of defects that were caused by drying or that were missed in the pre-drying preparation. For more detailed information see Chapter X.

260. Packaging and Packing

After the products have been dried and inspected, they must be packaged under conditions that assure freedom from contaminants and uptake of moisture.

Since oxygen causes deterioration of the product during storage, the filled container should be as free from air as possible. Replacement of air in the container with an inert gas, such as nitrogen or carbon dioxide, has been found advantageous for some products. In general, vacuum packing has not been found practical from a Military standpoint.

The package must be of material and construction that will protect dehydrated products from vermin, rodents, rain, sea water, ingress of air and moisture, and other contingencies of Military handling and storage.

Methods have been developed for compressing certain dehydrated products. Shredded vegetables, such as cabbage, have been compacted within the container by means of an hydraulic plunger to reduce bulk to about one-fourth to one-half the bulk of uncompressed dehydrated material.

Some dehydrated vegetables and fruits can be compressed even more in the form of bricks of moderately high density, without causing rehydration problems and without detracting from the quality of the reconstituted product.

Compression not only reduces space requirements for containers but also reduces the oxygen-to-solids ratio, thus tending to minimize deterioration due to oxidation.

The principal disadvantage of extreme compression is that highly compressed products are more difficult to rehydrate quickly and uniformly. Another disadvantage is that compression causes fracturing of some products so that they will not reconstitute to pieces of acceptable size and texture.

270. Warehousing and Shipping

Deterioration of dehydrated vegetables and fruits starts before the drying process has been completed, and continues until the product is used or discarded. Blanching, sulfiting, starch coating, drying to an adequately low moisture content, packaging in a tight container in an inert gas atmosphere, and storing at proper temperatures are employed to extend the useful life of the product. No single one of these is fully effective in itself; proper combination of these control measures is necessary for each product.

A very important factor contributing to long storage life, and the major factor which may be controlled after the product is packaged, is storage temperature. The rate at which most common dehydrated products deteriorate increases very rapidly as storage temperature increases, as shown below for products packaged with nitrogen:

Storage Temperature (°F.)	--	75	80	90	100	110	120
Approximate Relative Storage Life	--	100	50	18	8	3	1

Obviously, exposure of dehydrated vegetables and fruits to high temperatures, even for a short time during storage or shipment, should be avoided. The product will remain palatable 100 times as long at 75°F. as it will at 120°F. Life of the product is halved if storage temperature is increased only from 75°F. to 80°F. Many products for Military use have been judged on the basis of acceptability after 6 months storage at 100°F. It is obvious that storage below 75°F. would be most desirable.

Reconstitution and Cooking Principles

Restoring water to dehydrated foods is known as reconstituting, rehydrating, or refreshing, and is the first step in preparing them for consumption. A properly dehydrated food will absorb enough water when reconstituted to restore it almost to the original form and texture of freshly-prepared food. Reconstitution of vegetables and fruits may be accomplished by soaking and/or cooking.

In general, the need for soaking prior to cooking is governed by size, structure, and composition of the dehydrated food pieces. The soaking process is held to a minimum to reduce leaching losses of nutrient materials, to save time, and to avoid disintegration of food pieces during subsequent cooking.

Some dehydrated products may not require a preliminary soaking treatment as sufficient water is absorbed during the cooking process. Other dehydrated foods may require a soaking period for as long as several hours prior to cooking. Powdered and granulated products usually reconstitute readily when mixed with water.

A properly dehydrated and packaged vegetable or fruit that has been stored under suitable conditions can be prepared to give an attractive, flavorful, and nutritious food, highly acceptable to the consumer. The accomplishment of this goal is not an accident but results from the diligence and application of skills of all involved - the grower, the processor, the storage-and-transit handler, and the cook.

CHAPTER III

BUSINESS CONSIDERATIONS

Preliminary Questions

A. How Successful is a Dehydration Venture Likely to Be?

The varied experiences of those who started in the dehydration business during World War II ranged from total failures to complete successes. Many factors contributed to these differences. Among the factors that contributed to the failures are the following:

1) Inadequate working capital. Even though the plant may be completely paid for, the need for additional capital is substantial. The output from a 100-ton per day (raw material basis) potato dice plant may cost around $10,000 a day. Obviously a great amount of working capital is needed for such a scale of operation. A prospective dehydrator must not venture into this business unless he has an ample supply of necessary funds or definite assurance of funds or credit from reliable sources. Not only must normal operation be covered, but also many possible costly contingencies.

2) Poor raw material purchasing practices.

3) Inadequate, unsuitable, or poorly arranged plant facilities. The importance of proper engineering is evident.

4) Careless or ignorant management.

5) Poor location of plant with respect to raw material.

6) Costly fire losses.

7) Emergency shortages and delays in obtaining equipment, raw material, packaging supplies, and labor.

8) Poor location of plant with respect to sewage disposal. One plant, at least, was forced to suspend operations because it had no suitable way of disposing of its liquid wastes.

9) High cost of production -- often the result or existence of one or more of the above factors.

Much could be written about each of the foregoing factors. One of the purposes of this Handbook is to point out what must be done to avoid these pitfalls. The prospective dehydrator must inquire carefully into each of these factors for the

particular situation he is evaluating. His ultimate success will depend upon the care he has taken to avoid these as well as other causes of failure.

The dehydration plants that were properly set up and managed during World War II experienced very successful and profitable operations. It is obvious, therefore, that during emergency conditions such as those found during World War II, a dehydration venture has a reasonable chance for success provided that the requisites for successful operation are available or are provided.

B. What Does it Cost to Get into This Business?

For plants of 100-ton per day capacity the building and equipment costs may range from half million to a million dollars depending upon the commodity and upon the type of dehydrator used. Total capital and credit requirements are estimated to range from over a million to two and a half million dollars. It is evident, therefore, that a dehydration plant cannot be built and operated on a "shoe-string". Unless the prospective dehydrator is prepared to consider an investment of the magnitude mentioned, he should stay out of the vegetable or fruit dehydration business. Obviously there are many ways of reducing the amount of capital required; but unless investment economies are made prudently, the dehydrator may end up with an unprofitable operation.

C. How Complex is Dehydration?

Organic materials with a high degree of perishability are processed in these dehydration plants. Slight differences in operating procedures may make the difference between the production of an acceptable or an unacceptable end-product. It is important, therefore, that management and technologic skills of high caliber be obtained. Up to 100 people per shift may be employed in the plants processing 100 tons of raw material per day.

Processes range from manual to highly automatic. Expert advice on equipment and processes is mandatory.

D. Can the Plant be Used in Off-Season?

It is recognized that an idle plant is a costly one and that year-round operation would be desirable. Location of the plant in an area where raw commodity supplies are available during a long harvest season is advantageous. Additional types of commodities are not always available in either sufficient quantity or satisfactory quality in such areas. The best white potatoes for dehydration, for example, are grown in the northern States; the same applies to cranberries, beets, and apples. White potatoes are available from storage for sufficiently long periods of time to permit the plant to run eight or nine months a year. Plants using frozen materials, such as citrus juice concentrates and green peas and beans, can operate throughout the year.

A beet dehydration plant,on the other hand, probably could not run over four months a year. The plant might possibly operate on white potatoes from storage for another four months of the year provided that the plant is originally set up to handle potatoes satisfactorily and that suitable potatoes are available at reasonable cost.

E. How Long Does it Take to Get Started in This Business?

Some estimates allow six months for preliminary surveys, planning, and engineering. Another six months will be needed to build the plant and get it into operating condition. Delays in building the plant or in receiving equipment may greatly increase time needed to get the plant in operation.

One of the special problems involves procurement of suitable raw commodity supplies. A whole year may be required, from the time of activating plans for a dehydration enterprise, to place contracts for and obtain the raw commodity from growers. If price considerations are waived, a plant may be able to get into production much quicker by buying its initial requirements on the open market.

Relation of Federal Agencies to Emergency Production

Responsibilities and functions of the various governmental agencies change. In any future emergency duties of the present federal agencies may be different and, perhaps, supplemented by the responsibilities of new organizations. Several of the principal agencies, however, may retain many of their present functions.

Military procurement will probably continue as a responsibility of the Quartermaster General. Raw material considerations will doubtless be under some agency reporting to the U. S. Secretary of Agriculture. Labor availability and regulations will probably be guided by the U. S. Department of Labor. Industrial allocations are likely to be administered by the agency responsible to the U. S. Department of Commerce. Fuels may be regulated by a representative of the Secretary of Interior.

The "Defense Production Act of 1950", otherwise known as Public Law 774 of the 81st Congress (64 Stat 798) restated the principles to be invoked in the case of emergencies. This act, along with its amending and related acts of the 81st and later Congresses, form the bases for Executive Orders and various agency regulations that provide more specific formulae and procedures than are written into the laws themselves.

Matters related to defense regulations and procedures in an emergency are published yearly as Title 32A, the "National Defense Appendix," of the Code of Federal Regulations. Interim regulations and procedures are printed (and indexed) in the Federal Register, which is issued daily. Both the Code, referred to as C.F.R., and the Register, referred to as FR, are published by the Federal Register Division of the National Archives and Records Service, U. S. General Services Administration. They are available for purchase from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

Matters such as procurement, priorities, responsibilities of processors to labor and to raw material suppliers, and special depreciation rates are to be found in the bound and the current reference to Title 32A, whether in C.F.R. or FR. These apply to both military agencies and to regular non-military government Departments, such as Agriculture, Treasury, and Labor.

Depreciation Factors

The amount of depreciation that can be charged off yearly is of utmost importance for an emergency plant that may operate for only a short period of time. The financing of emergency plants may be dependent upon reasonable assurance that the facilities will be all or largely amortized during the period of the emergency.

For dehydration plants discussed in this Handbook, two possibilities exist for determining the write-off period that may be allowed: (a) normal write-off, or (b) an accelerated write-off.

A. Normal Write-Off

The Internal Revenue Code includes the following definition: "Depreciation -- A reasonable allowance for the exhaustion, wear, and tear of property used in the trade or business, including a reasonable allowance for obsolescence."

Two principal types of obsolescence are recognized: (1) normal obsolescense such as would be attributable to the normal progress of the art, economic changes, inventions, and inadequacy to the growing needs of the trade or business, and (2) extraordinary or special obsolescence which may be caused by revolutionary or radical changes unforeseen and unpredictable by their nature when the property was acquired. Only the first form mentioned (normal obsolescense) is included in the normal allowable depreciation charge together with the allowance for physical wear and tear. Deductions for extraordinary or special obsolescence may be charged over the period beginning with the time such obsolescence is observed and ending with the time the property is abandoned or replaced.

The allowable charge for depreciation is calculated by spreading the net cost of the property over its estimated useful life. This net cost is the original installed cost plus any additions, improvements, and betterments, minus estimated salvage value at the end of its useful life. The period of time over which the cost of the property is spread is called the write-off period.

Peace-time depreciation charges are usually guided by <u>Bulletin F</u> of the Bureau of Internal Revenue "<u>Income Tax Depreciation and Obsolescence Estimated Useful Lives and Depreciation Rates</u>." This was published in January 1942, and a revision is anticipated. The figures given serve as a guide and in no sense are intended to have the force and effect of a Treasury Decision. The normal life-expectancy periods as given in <u>Bulletin F</u> for the buildings and various items of equipment likely to be needed in a vegetable or fruit dehydration plant are summarized in Table V at the end of this section. Under emergency conditions the acceptable periods will likely be shorter than those given since the <u>Bulletin F</u> data apply to usual peace-time operations.

There are many methods for apportioning the total amount to be depreciated over the normally estimated life of the property. These methods are reviewed on pages 17-21 to 17-35 of the 4th edition (Rufus Wixon, editor) of <u>Accountants' Handbook</u> (published in 1956 by the Roland Press Company, New York). Some methods in use are also discussed in <u>Bulletin F</u>. previously cited. The Internal Revenue Service does not require that any specific method be used, but the methods used must be reasonable and be consistently applied.

B. Accelerated Write-Off

Accelerated write-offs of manufacturing facilities, during recent emergencies, usually have been amortized over a five-year period. The amount of accelerated write-off permitted has varied from 25% to 100% of the total cost of the facilities--the actual percentage allowed being based upon the need for the products to meet requirements and upon the anticipated post-emergency use of the plant. Special authority must be obtained from the Government agency concerned before a dehydration plant can use an accelerated write-off of plant investment.

TABLE V

Estimated Average Useful Life of Buildings and Equipment 1/

Item	Years 2/	Item	Years 2/
Food Processing Equipment		Factory Buildings	50
Blanchers	10		
Blowers	15		
Casing machines	15		
Choppers	12	Warehouses	75
Closing machines	15		
Conveyors	15		
Cookers	15		
Corers	20	Office Equipment	
Crates, process	10		
Cutting tables & seats	15	Safes and vaults	50
Dicing machines	10	Furniture, etc.	20
Dryers	15	Mechanical equipment	8
Elevators, boot			
bucker, or chain	15		
Fans, blower or exhaust	15	Restaurants, Bars, & Soda Fountains	
Fillers, can	12		
Graders	17	Average life from	
Hoists	20	10 to 14 years	
Kettles, cooking	20		
Labeling machines	15		
Mixers	20		
Parers	20	Motor Vehicles	
Pulp machines	15		
Pumps	20	Passenger autos	5
Retorts	25	Trucks - light	4
Retort cars, steel	20	- medium	6
Retort trays, steel	10	- heavy	8
Rinsers, rotary	15	Trucks (inside)	15
Scalders	12	Tractors	6
Scales, platform	20	Farm tractors	10
Sealing machines	15	Trailers	6
Seamers	12		
Shakers	15		
Sizers	15		
Slicers	15	Agriculture Facilities	
Sorters	17		
Stencil machines	20	Buildings	50
Tanks, cypress or redwood	17	Equipment	15
glass lined	25		
steel	25		
Thermometers	10		
Trucks	15		
Washers	15		

1/ U. S. Bureau of Internal Revenue Bulletin F, (Revised Jan. 1942): Income Tax Depreciation and Obsolescence Estimated Useful Lives and Depreciation Rates. Washington, D. C., 1942. 93p.

2/ Under war emergency operating conditions the useful life may be reduced by 20% to 30%. If somewhat unsatisfactory substitute materials are used in the construction of the equipment, the useful life will be further shortened.

Contingency Considerations

Plants operating during a national emergency may have many unpredictable and out-of-the-ordinary situations to contend with, and certainly emergency plants should provide in advance for means of meeting as many of these situations as practicable.

Although each contingency is a specific problem, a great majority of them will come within categories which may be anticipated in a general way. Suggestions are given below, based upon experience during World War II, concerning many of the possible realms in which such problems may be expected to occur in the operation of an emergency type plant. There is no attempt to list these contingencies in any order of importance or their likelihood of occurrence. Furthermore, by definition, no list of possible contingencies can be complete.

Personnel. Personnel problems may arise at any level -- from the general manager to the workers harvesting the commodity. Perhaps one of the biggest problems may arise from personnel getting opportunities to work at other defense plants at higher wages. Military recruiting also will take its toll of workers. Generally, wage levels are lower in food processing plants than in many competing industries. The large number of unskilled workers needed, and the type of work done, make possible the employment of a big proportion of women workers.

Supply of Raw Material. The variations in climatic conditions may seriously affect the date and rate of harvesting the raw commodity. There will be seasonal differences in the quality and quantity of raw commodity which will affect production rates and total plant output. There is a possibility of virtual crop failure.

During a season of generally short supply of a commodity, growers may break their contracts, with the resulting necessity of the dehydrator having to pay much higher prices for the commodity from other sources. Bumper crop production from contracted acreage will create storage or/and marketing problems for the excess commodity.

There are always the problems of getting sufficient seed, fertilizer, insecticides, irrigation water, and suitable land acreage to supply commodity needs of the plant.

Waste Disposal. Changes in operating conditions or sanitation laws may seriously affect the disposal of wastes from a dehydration plant. Establishment of other manufacturing plants in the area may force the dehydration plant to change completely its methods of waste disposal. Changing regulatory controls may prohibit further use of existing waste disposal methods.

Water Supply. Seasonal variations in rainfall or additional demands on the water source may curtail the supply of water to the dehydration plant. The water source may become contaminated to the extent it is unsuited for use in a food processing plant, or at least may require costly treatment prior to use.

Other Utilities. The total demand of the area for electric power or gas may increase during an emergency period to the extent that the dehydration plant can not operate at its expected rate. Break-downs in the utility supply facilities can cause serious production delays and markedly increase production costs. Operations under an "interruptible gas schedule" may result in occasional shut-downs unless a reserve supply of tank gas or oil is available. To insure continuous operation, contracts on a firm basis, although demanding high rates, may be advisable.

Facilities. In any plant, there is always the possibility of break-downs of equipment. Replacement or expansion of facilities during an emergency is likely to be difficult.

Patents. There is some possibility of incurring patent litigations or having to pay royalties for use of certain processes and equipment. An emergency type of plant producing for the Federal Government, however, may get assistance in these problems from the contracting agency. A prospective dehydrator should carefully investigate the patent status of facilities and processes he proposes to use.

Producing Products to Meet the Military Needs. Military requirements are constantly changing. Changes in current Specifications for the products may be necessary and may require drastic changes in the processing steps. The needed quantities of the products may change abruptly, causing a revision of the original contract.

There may be unexpected changes in packaging and packing requirements. Changes in shipping schedules may cause unexpected demands for warehousing finished products at the plant.

There is always a possibility that the finished products may not fully comply with the contract agreement. Such products may be rejected entirely, or accepted and paid for at a reduced price. Until a final decision is made there will be a tie-up of product, of management time, of storage space, and of funds invested in the product.

Time Required for Receipt of Product Payment. Government procurement during an emergency period is usually a complex procedure. Many people and groups are required to test and approve the finished product, to approve payment on the contract, and to make payment. Delays may occur at any point, and the dehydrator may experience considerable delay in receiving the money due him. At an expenditure rate of approximately $10,000 per day during the operating season, the dehydrator may tie up a very substantial amount of operating capital during the interim awaiting payment for delivered goods.

Resume' of Procurement Procedures of Military Subsistence Supply Agency in Purchasing Foods

A. General Procedure

All food items whether perishable or non-perishable are purchased by negotiations. Every interested supplier is sent a "Notice of Intent to Purchase," or what is briefly called a "NIP". These notices give information as to quantities, Specifications, time and place of delivery, and other necessary details. Only one copy of the "Notice of Intent to Purchase" is sent to each prospective supplier, and this copy is kept by the supplier and not returned as was formerly done. Interested suppliers inform the Military Subsistence Market Center specified in the "NIP" at what price they will supply all or part of the projected purchase.

All offers to sell are reviewed by Military Subsistence Supply Agency to insure that the greatest possible economy and efficiency are secured. The Market Center awarding the contract has the responsibility of seeing that the terms of the contract are met.

Suppliers should contact the Market Center in whose area they are located for current detailed information concerning procurement procedures.

B. Awards to "Small Business"

By the joint determination of certain officials in Military Subsistence Supply Agency, all projected purchases are considered as to their relationship to what is considered "Small Business." Some awards are restricted entirely to "Small Business," others are partially restricted, thus assuring a fair distribution of awards to small as well as large enterprises. The Small Business Specialist at any Market Center can be contacted to determine the requirements for qualification as a "Small Business" concern.

C. Current Purchases of Dehydrated Foods

Military Subsistence Supply Agency is currently purchasing substantial quantities of dehydrated potatoes, onions, and apples. Since most of the usual suppliers of these particular foods are in the West, the Oakland Military Subsistence Market Center has the responsibility of these purchases.

D. Deviations From Specifications

In case of deliveries of dehydrated foods not meeting Specifications, one of three procedures is used. The foods can be (1) rejected, (2) accepted, or (3) accepted with a penalty or at a price commensurate with the value of the product. For further details, see QM Circular #23, 14 February 1956.

E. Publications of Awards

A summary of the awards of Military Subsistence Supply Agency is given in the Synopses of Awards published by the U. S. Department of Commerce.

F. References

1) Military Subsistence Supply Agency Operating Manual, 3000 Series

2) Military Subsistence Supply Agency Operating Manual, 3300 Series

3) Q.M.C. Circular #23, 14 February 1956. "Contracts -- Policy for Acceptance of Q.M. Purchased Nonperishable Subsistence"

Financial Requirements

Adequate financing is a prime requisite to the establishment of a successful dehydration plant. Failure to provide for financing all costs associated with getting the plant into operation resulted in many failures during World War II.

In addition to the obvious costs of the building and equipment, many other costs will be experienced. Extensive preliminary plans and surveys are required before plant construction can start. Usually key personnel will be hired well in advance to make these studies and to set up the organization, but outside consulting services may also be necessary. Having such services available at least for six months preceding the first operating season may be advisable.

Even after the plant is built, many extensive changes may be necessary to get it into successful operation. Equipment and process modifications and many other contingencies may materially affect the total capital requirements estimated in original plans.

It is often agreed that the dehydrator will make advance payments to growers for such things as seed, fertilizer, irrigation, and spray material, and for harvest costs. It may be necessary to make substantial deposits for utility services needed and to make advance payments for insurance. Packaging supplies and other materials will have to be purchased in advance to have them available when plant operations begin.

Another important factor determining amount of capital needed is the length of time that elapses after production is started until payment is received for the finished and accepted product. Considerable product may be produced that does not meet Specifications. If it is rejected, the costs expended in producing it may be a total loss. Even if it is accepted at a discount, considerable time may be involved in negotiation.

After the Government accepts a finished product, some time will elapse before payment is made to the dehydrator. Government payments in an emergency cannot be handled as informally and quickly as private transactions often are, so the delay may be considerable. It is reasonably safe to assume that about 90 days will elapse before payment is received. In the light of uncertainties in an emergency period, the dehydrator should check to see what payment procedures may be expected for his situation and plan his financial requirements accordingly.

After plans for a dehydration plant have been firmly established, a realistic budgetary plan should be formulated to determine estimated expenditures and incomes for the business. The budgetary planning should be done on a month-by-month basis from the starting of any expenditure (planning and erecting facilities) to the time when cash receipts exceed cash expenditures. It is only in this way that a true picture can be established as to when and how much capital will be required.

Capital requirements may be met partly by assets invested by the owners and partly by credit from sources such as:

1) Government financing or advances

2) Loans secured by physical assets

3) Open account or credit purchasing

4) Contract agreements with growers for delayed payment for raw commodities

5) Bank loans on production contracts and/or bonded warehouse inventories of finished product awaiting shipment to the purchaser

6) Unsecured loans from financial institutions

The fixed capital requirements will be considerably reduced if suitable buildings and grounds, and perhaps some equipment, are leased rather than purchased and the rentals paid as operating charges.

In past emergencies, when private financing was not adequate, financial assistance was granted to some dehydration plants in several ways by the appropriate Governmental agency.

Advance, partial, or progress payments in some cases were made in anticipation of the delivery of the product for which a contract existed. Such payments created a lien against the contractor's property, such as the material in process or the equipment and plant owned by the contractor, according to the situation that existed at the time of payment.

Where the production was considered essential and no alternative source of financing was readily available, loans were sometimes made or guaranteed by the Government. The agency that might provide the money would consider such factors as: need for the proposed plant in fulfilling emergency requirements, amount of loan requested as related to the equity investment of the applicant, and collateral together with past and prospective earnings of the applying party. Usually a statement regarding the need for the new facilities was obtained from the Federal agency interested in the final product.

For most recent information, the prospective processor should communicate with the contracting officer for his district, a Government Small-Business Specialist, and/or his local bank.

CHAPTER IV

ORGANIZATION AND MANAGEMENT SERVICES

Principal Key Personnel Needs

It is highly desirable for the management of a dehydration plant to have a background of sound experience in the processing phases of dehydrating, canning, or freezing of foods. Experience in the fresh produce business is also very valuable. Lack of proper background may result in a costly initial operating period for gaining experience necessary to produce satisfactory products.

Successful operation of a food dehydration plant requires sound and energetic management, technical skills, and know-how in food processing. These abilities must be organized and the work coordinated in such a way that satisfactory products are manufactured in accordance with desired schedules. The purpose of this chapter is to indicate the key personnel and the special services required to operate successfully a plant to produce dehydrated vegetables or fruits for Military Forces during a national emergency.

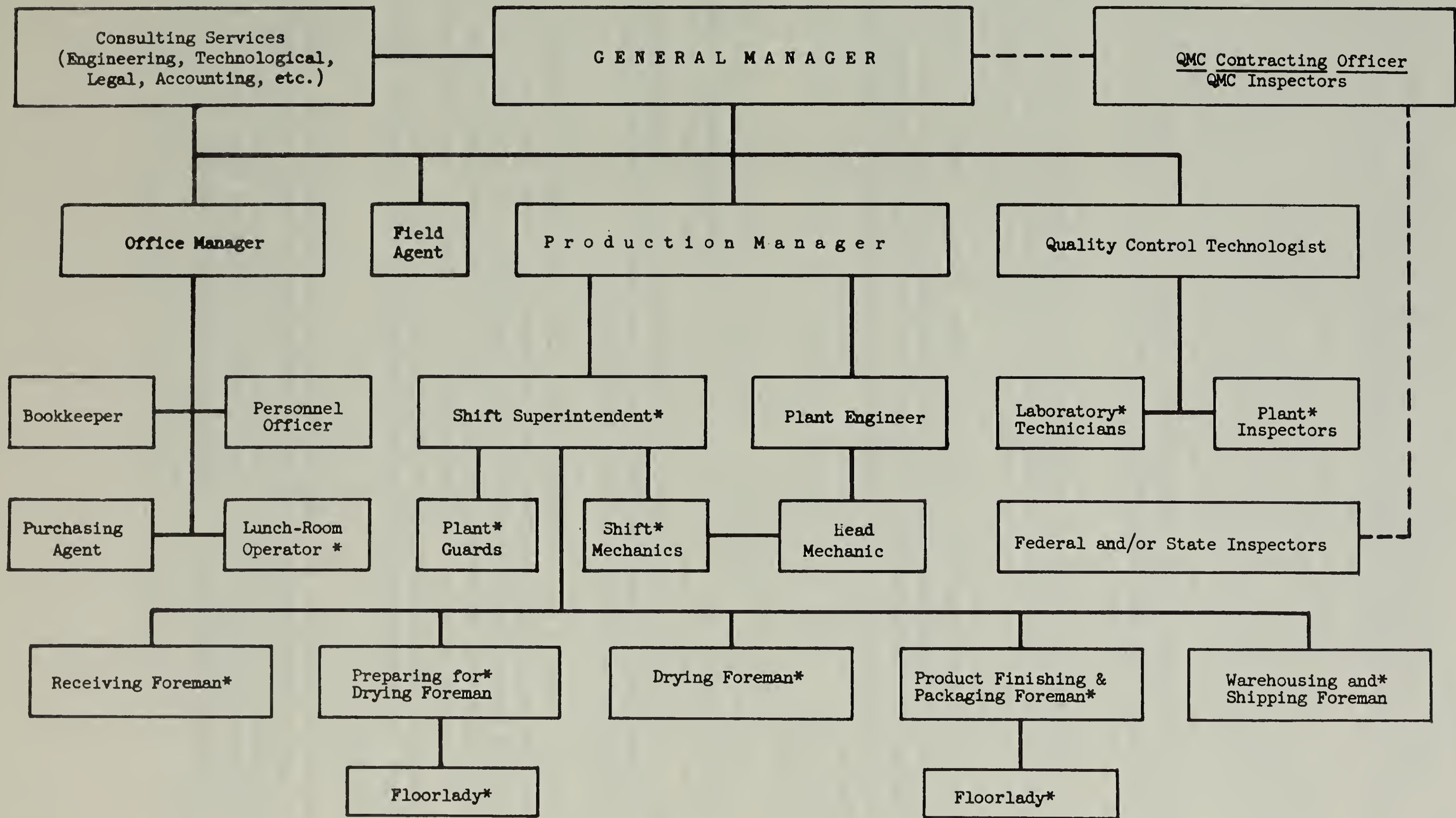
The organization and lines of responsibility for a dehydration plant, of a size suitable for emergency production needs, are shown in Figure 1. The plant organization provides four key administrative men (office manager, field agent, production manager, and quality control technologist) who are responsible directly to the general manager. 1/ There must be close liaison between these men to assure smooth operation of the plant.

The abilities of various key personnel and the size of plant will determine whether or not each job shown on the chart will require a separate individual. In smaller plants several functions shown on the chart may be filled by one person. 2/ Men filling these key positions will be employed the year-round because repairs, plant modifications, planning next year's production, and obtaining operating supplies will require their services. It is important that an emergency plant make every effort possible to retain key personnel in off-seasons as finding properly qualified people for the next operating season will be more difficult as emergency conditions continue.

1/ A civilian market plant also will need a sales manager, directly responsible to the general manager, but he will not be required for the kind of plant under consideration in this Handbook.

2/ For example, an office manager also might fill the job of purchasing agent, the production manager might be the day-shift superintendent, one foreman might be in charge of receiving and preparing operations, etc.

FIGURE 1 -- ORGANIZATION CHART FOR A VEGETABLE OR FRUIT DEHYDRATION PLANT



(* Needed for each Operating Shift)

A. General Manager

The general manager preferably should have a broad and successful background in planning and administering complete organizations, i.e., organizations that perform (or are at least responsible for) all the fundamental operations of manufacturing, selling, and any necessary development of products and methods for their manufacture. A knowledge of food processing is essential. Successful experience in dealing with and buying from vegetable and fruit growers is extremely valuable. Some successful dehydration plant managers during World War II had been shippers of fresh produce.

The general manager must know the requisites for supplying Military Agencies with the dehydrated products that his plant is capable of producing. These requisites include methods of contracting, shipping requirements, renegotiation aspects, and many other similar points.

Managing a dehydration plant of any size is a full-time job and will not permit the general manager to have other responsibilities and interests that keep him away from the plant. During the operating season many problems may arise each day that require careful consideration and immediate action. Even an hour's delay pending a decision can be very costly in commodity spoilage, labor costs, overhead charges, and other expenses. It is imperative that the general manager not only have the know-how for solving these problems, but he also must have the ability, courage, and authority to make decisions quickly. An owner-manager combination is considered ideal for this position.

B. Field Agent

One of the key men for a dehydration operation is the field agent responsible for negotiating purchases and deliveries of fresh commodities needed. The plant is dependent on this man to keep it supplied with adequate quantities of raw commodities of varieties and quality suitable for dehydration. A most crippling production limitation of World War II dehydration plants was lack of adequate procurement and properly scheduled deliveries of raw commodities.

In order to do a sound job of procurement and scheduling of deliveries, the field agent must know amount of raw material required to be on hand at all times in the plant, storage characteristics of the raw commodity, and storage facilities available in the plant and in nearby areas. He works cooperatively with the general manager, production manager, office manager, and quality control technologist (1) to establish detailed schedules and maintain delivery of raw materials throughout entire operating season, and (2) to determine and obtain quality required to meet Specifications.

The field man should have a background of specialized training, equivalent to a degree in agricultural sciences from a reputable college or university, plus several years experience in all phases of growing, harvesting, handling, and storing the particular raw commodity. It is very important that he have specific knowledge of the growing areas which will be supplying the plant's needs.

The field man should have sales ability so he can convince the prospective grower of the need, importance, and probable profit in growing the particular crop, and furthermore, to grow it in such a way that good yields of high quality will result. The field agent will be more successful if he is well known in the district and has a good professional reputation.

C. Production Manager

The production manager has full responsibility for directing all processing operations -- from receiving the raw material to shipping the finished products.

The shift superintendents, who report directly to him, have immediate responsibility of operating the processing plant. The foremen, shown on the organization chart, should be men with practical industrial experience of some kind, although they may have to be trained for the specific job in this plant. Floor ladies supervise groups of women workers (principally in the preparation and finishing-and-packaging operations). Duties of the floor ladies also include: (1) on-the-job training, and (2) acting as spokesmen and advisers.

The plant engineer is the key man in setting up plant and equipment, but he also has the important function of keeping equipment in working order and of improving operations with new equipment and methods. The engineer will have a head mechanic and a staff of assistants who maintain the plant in proper condition and make necessary modifications and improvements in equipment. Each shift will need a mechanic who is directly responsible for keeping equipment in operating order. The mechanics should be able to do piping of all kinds, sheet metal work, welding and cutting, painting, carpentry, concrete and masonry work, and electrical wiring.

D. Quality Control Technologist

All plant operations must be carefully and continuously controlled (1) to retain the maximum of original flavor, appearance, and nutrient values of fresh materials, and (2) to insure that the product fully complies with Specifications. The quality control technologist must set up testing facilities, supervise or perform tests of many kinds, interpret test data as to adequacy of processing operations, and recommend (and assist in putting into practice) operational modifications where needed. In many plants, the quality control technologist has authority to change any operating procedures that do not achieve the desired results, or, in extreme cases, he may have authority to shut down the plant if a satisfactory end product is not being produced. Usually, however, the quality control technologist makes his recommendations to the general manager who decides what action should be taken. Regardless of administrative procedure used, actual responsibility for quality control and for producing acceptable products rests with the quality control technologist. A research program should be considered in order to improve current procedures and to anticipate future developments in dehydration processes and products.

The head of this department might be a food technologist, chemist, or chemical engineer. Knowledge of bacteriology and sanitation is important. Comprehensive experience in related types of food processing, particularly in frozen vegetables and fruits, is good background for a new person in dehydration.

One or more laboratory technicians (the number depending upon size of plant) will be needed for each shift to make routine tests that are required for proper quality control. These people preferably should have some technical training. A substantial part of the test work can be done satisfactorily, however, by an intelligent person with only on-the-job training by the quality control technologist.

Continuous product inspection must be carried out at various points along the processing line under the technical supervision of the quality control technologist.

The following Government inspection services can be of material assistance in maintaining controls that assure production of acceptable products. Government inspectors are not administratively responsible to the plant management but have functional responsibilities which can best be coordinated through the quality control technologist.

1) Inspection of raw materials -- Federal and/or State inspectors may be obtained on a contract-fee basis from the U. S. Department of Agriculture, or from the various State departments of agriculture, to inspect raw commodities used by the plant. A more detailed discussion of such services is given in Chapter VI.

2) Inspection of processing operations and of finished products -- The Processed Products Standardization & Inspection Branch, Fruit and Vegetable Division, Agricultural Marketing Service, U. S. Department of Agriculture, will supply inspectors, on a contract-fee basis, for inspecting processing operations and finished products.

The Government agency responsible for actual acceptance of the products, will make whatever inspection and testing it deems necessary in accordance with Specification requirements for the particular product.

E. Office Manager

The office manager is usually in charge of nonproduction functions of the organization plus those responsibilities not specifically assigned to the field agent, production manager, or quality control technologist. In large plants, some of the duties of persons who would ordinarily report to the office manager may be sufficiently important that they may be directly responsible to the general manager. This variation from the proposed organization chart may apply particularly to the personnel officer and the purchasing agent.

One of the most important responsibilities of the office manager is maintaining adequate records of all business transactions of the organization -- bookkeeping, cost accounting, payrolls, banking activities, contract agreements (purchases, sales, equipment, services, etc.), tax calculations and records, inventories of all physical assets, and budgetary plans for current and future fiscal periods. It is his responsibility to keep up-to-date on Government regulations regarding procurement procedures (for equipment, manufacturing supplies, equipment parts, etc.), transportation of materials and finished products, labor and plant operations, taxes and amortization, and other factors affecting the operation of the business.

The office manager should have had prior experience in these functions. Formal training in business management with emphasis on accounting is probably the best single type of background for this particular job. Any additional experience in manufacturing, selling, and distributing is very helpful.

In addition to a field man for procuring raw commodities for processing, a general purchasing agent may be needed by a dehydration plant. Most items to be purchased--particularly metal containers, packing materials, equipment and equipment parts, automotive supplies, water-conditioning and sanitizing chemicals, etc, -- require considerable negotiating and expediting efforts to obtain them during an emergency, even with proper allocations and priorities.

There is need for a personnel officer who will interview and hire labor and maintain good personnel relations both within the plant and with labor unions of the area. He is responsible for payrolls, time cards, and other personnel records. During a national emergency it may be necessary for the personnel officer to recruit labor.

The plant guards (watchmen, gate keepers, etc.) and the lunch-room operators are, as a rule, responsible to the plant manager, but in some cases they report to the office manager.

Management Services Needed

Seldom are any two processing plants built and operated alike. Food dehydration plants are no exception. Each plant must be specifically and completely planned to fit the particular conditions anticipated for that plant.

Any group which contemplates going into the food dehydration business should seek assistance from:

1) The Industrial Mobilization staff of the Quartermaster Corps

2) Any advisory committee which may be appointed by the Office of the Quartermaster General from the dehydration industry (active processors, equipment manufacturers, suppliers, growers, etc.)

3) Competent consultants or consulting organizations serving the dehydration industry

A. Technical Consulting Services and Assistance

Competent individuals and organizations can offer sound advice in the broad considerations of new projects. They can help develop a usable set of plans for a complete plant and can assist in compiling estimates of the costs of establishing and operating such plants.

Specific consulting needs may comprise or cover any or all of the following:

1) Government procurement and inspection requirements and policies

2) Management planning

3) Raw commodities and manufacturing supplies needed

4) Process engineering and quality control

5) Facilities and construction needs

6) Fixed and operating capital needs and cost controls required

Few plants can afford to maintain on their permanent payroll management and engineering skills equivalent to the services offered by competent consultants. Use of consulting services to supplement well-chosen plant personnel, however, can accomplish the desired goals.

It may be advisable to retain such consultants or consulting groups on some sort of continuing basis. Cost of consulting services may be minimized by calling on consultants only as the need arises, but this procedure places a considerable burden on management and may result in failure to take full advantage of the consultants' knowledge.

It is essential that consultants or consulting organizations be selected that have established reputations for doing a sound and ethical job for their clients. A poor consultant is worse than none at all.

In addition to independent consulting organizations, plant builders and manufacturers of dehydration plant equipment may be good sources of assistance. Caution should be exercised by the plant management in following this type of advice, however, as sometimes an over-zealous builder or equipment manufacturer may make recommendations that sell more materials, services, or equipment, but may not meet the customer's needs. Advice should be heeded only from reputable and well established builders and manufacturers.

Many dehydration plants have been built and equipped in the past that could not be operated successfully. The consultant, consulting firm, or builder responsible for designing and constructing the facilities should be required to put the plant in operating condition, according to the terms of the contract, before the plant is accepted by the owners and management. For such test purposes, actual full-scale production runs should be made on fresh commodities from their proposed sources.

Improvements in food dehydration equipment and techniques are constantly being developed. The terms of Specifications for dehydrated vegetables and fruits change from time to time in recognition of these advances. The general manager of the dehydration plant should be farsighted enough to recognize the certainty of change in dehydration procedures and to insist that his technical staff keep abreast of all new developments. Close contact should be maintained with (1) the Research and Development Branch, Military Planning Division, Office of the Quartermaster General,

Washington, D. C.: (2) Food and Container Institute for the Armed Forces, U.S. Army, Chicago, Illinois; and (3) Associates, Food and Container Institute (headquarters at Chicago Quartermaster Office). 1/

Trends in food dehydration may often be recognized in the findings of research laboratories which are interested in this field; many of these laboratories are Federal- or State-supported, and information can be obtained from them without cost or obligation. Acquaintance with agricultural experts of the State Colleges and State Agricultural Experiment Stations serving the area in which the plant is located is important. Raw material production and associated transportation and storage problems are responsibilities of ~~Product~~ Farm Research, Agricultural Research Service (ARS), U.S. Department of Agriculture. Dehydration technology and processing problems are under constant study in the field laboratories of Utilization Research and Development, Agricultural Research Service, U. S. Department of Agriculture. The dehydration plant operator can and should make full use of these public services.

B. Accounting and Bookkeeping Services

A dehydration plant operating to fill government contracts will have complex and changing requirements in its bookkeeping and cost accounting records. It is urged that a new plant employ, in the very beginning, a well-qualified accounting firm to establish an accounting system that will serve all the purposes. This accounting firm should be retained as a consultant to see that the plant's records are kept in accordance with changing laws and regulations. Properly kept records are necessary for obtaining materials and equipment under priority systems, for tax computations and amortizations, and for possible renegotiations of prime or subcontracts. A suggested guide for an accounting system is included in Chapter XII.

C. Legal Services

It is hardly necessary to point out that a dehydration plant, like most business enterprises, will need to retain competent legal counsel for assistance in establishing valid contracts and for advising in many other business matters.

1/ Associates, Food and Container Institute is a quasi-official organization whose members are experienced and/or doing work in the dehydration field.

CHAPTER V

SELECTION OF A PLANT LOCATION

In any discussion of factors affecting the choice of a location for a vegetable or fruit dehydration plant to meet national emergency needs, certain general considerations must be acknowledged:

1) Many factors which are important in a normal competitive economy may not be applicable in an emergency situation.

2) The general area in which a plant is to be located will be influenced by policies and decisions of Government groups charged with responsibilities for planning and authorizing emergency production facilities at the time the new plant is under consideration.

3) Military or other reasons may require that emergency plants be established in locations which do not meet the requirements outlined herein, but an effort should be made to satisfy as many of the requirements as possible.

4) The availability of capital necessary for such an enterprise should impose no unreasonable geographic limitations.

5) The needed management and technical skills for operating such a plant can probably be brought to the selected location, but general labor should be available nearby.

If this is to be the first food processing plant in an area, it will be important to find out why others have not been established there. There may be good reasons that can adversely affect operation of the proposed plant.

Location and Adequacy of Raw Materials

Figure 2 shows the location of existing vegetable and fruit dehydration plants, as well as other such plants that received procurement contracts from Government agencies during World War II.

Ordinarily it is best to plan initially the dehydration of only one commodity, and preferably in an area with a long operating season. A six-to-ten-month operating season is possible for vegetables and fruits in certain locations.

A dehydration plant should be located as near the sources of raw commodities as practical. There are three principal reasons for this. 1/

1) It is absolutely necessary that raw vegetables and fruits reach the plant in excellent condition. The farther the raw material must be transported the greater will be requirements for more careful handling to prevent damage.

2) Transportation services may be inadequate during a national emergency, thus making long and regular hauls of perishable goods very uncertain and perhaps impossible.

3) The high shrinkage ratio between raw commodities and dehydrated products puts the far greater burden and increased cost on handling and shipping the raw materials than on the finished products.

Labor Availability, Labor Relations, and Living Conditions in Area

A careful survey must be made of the prospective area to see if there is a sufficient supply of suitable labor. A new plant entering a community which is already experiencing a labor shortage may expect high labor turnover and may be forced to pay premium wages. (The Bureau of Labor Statistics, U. S. Department of Labor, publishes periodic reports showing areas of labor scarcity and surplus.) The survey should include study of local labor-management relations and of the responsibilities shown by labor union groups with which the management will have to deal.

Since the majority of required workers can be trained in a relatively short period of time, it is not necessary to select an area having concentrations of skilled labor. In fact, absence of other plants to compete for labor may be highly desirable. Smaller towns in farming areas have been found to be good sources of labor for vegetable and fruit dehydration plants. Some of these plants can operate on certain products through the winter months when farming has the least call for labor. In these smaller communities, labor conditions are generally quite stable. In the past, labor has been imported from other States and even bordering Countries to help in critical labor shortage areas.

Public transportation is generally not adequate for carrying workers to and from the plant, and transport is largely dependent upon private vehicles. Transportation of personnel to and from the plant must be assured in some way. The use of company-operated busses may be necessary to provide transportation.

Where a high percentage of the labor consists of transients the housing problem often becomes acute, and provision must be made in the form of company-sponsored housing projects, trailer camps, or other facilities.

1/ Cf. "Plant location in agricultural process industries," by W. L. Faith, CHEMICAL ENGINEERING PROGRESS 45:304-13. May, 1949.

Community Attitude

Community attitude is important. A plant built in a community that sincerely welcomes its establishment will find easier answers to many of its problems. A reciprocal "play-fair" attitude by both sides will assist materially in smooth and uninterrupted operation of a plant.

The plant management should comply with local customs and laws to avoid misunderstandings with authorities concerning especially control of odors, dusts, insects, rodents, and waste disposal. Strict observation of zoning regulations and public opinion in a community is important.

Of particular importance in maintaining good relations with a community is the matter of plant odors. A plant should be located so that prevailing winds do not carry odors from waste disposal or processing operations across populated areas.

Transportation Facilities

A successful plant must have adequate transporation facilities to get its raw materials into the plant and to ship out finished goods. Raw materials are preferably brought in by truck from nearby areas. Raw materials from remote areas, however, may arrive by rail. Rail transportation is often used for shipping packaging materials to the plant and for shipping out finished products, although trucks are also used. Unless the plant is served by its own rail spur, extra handling costs will be incurred for rail shipments.

It is advisable for a plant to have both rail and truck facilities. The likelihood of breakdowns, shortages, and other disruptions occurring simultaneously to both types of transportation is very remote. Thus shipments seldom will be interrupted if both types of facilities are available.

Scale of operation, length of operating seasons, and proximity to raw material sources are major factors in determining whether or not the plant should own its trucks or contract for this service if trucks are available for hire.

Ample roadways, parking space, and turning areas sufficient for long trucks and trailers must be provided. They should be hard-surfaced to reduce dustiness, improve general safety, and provide all-weather use.

Utilities

The utility needs for a proposed plant should be discussed with respective suppliers of these services. Inquiry should be made concerning reserve capacities, peak load requirements of the area, and plans for expanding these services to meet anticipated future needs.

A. Water

One of the principal utility requirements for a dehydration plant is an ample supply of good water. 1/ The water should be well within the tolerance limits established for food processing plants. Substandard water may cause finished products to be contaminated with bacteria and foreign matter, or to have off-flavors. It is desirable that the water be of moderately low hardness for processing operations. Boiler feed-water must be properly conditioned or the resultant scale formation in boilers and pipe-liners will be a continuing source of trouble. Water used in processing operations and for cleaning and sanitizing equipment must be of a standard of purity suitable for drinking. If plant water supply is not obtained from an approved municipal system, some type of treatment may be required.

An adequate supply of water is becoming one of the principal criteria for selecting plant sites in many areas. A typical vegetable dehydration plant processing 100 tons of raw material per day may require between 300,000 and 1,000,000 gallons of water each 24 hours, and perhaps more. Often plants cannot be erected in otherwise desired locations due to an obvious lack of water. During World War II a number of plants were, unfortunately, built without having adequate provision for the desired quantity of suitable water. The problem is even more acute today. However, any area having sufficient water for growing fresh commodities should have enough water for a dehydration plant.

Water conservation may be important in some areas. Over-all water savings can be accomplished by (1) carefully using water, (2) recirculating or reusing water where permissible, and (3) maintaining equipment at optimum efficiency to make effective use of water.

B. Fuel

The average fuel requirement for a typical 100-ton per day dehydration plant amounts to approximately 25,000,000 B.T.U. per hour - equivalent to either 25,000 cubic feet of gas or 185 gallons of light fuel oil per hour. For indirect-fired dryers, the fuel requirement may be slightly more (perhaps 15% additional) than for direct-fired, but there may be tangible gains through (1) better control of operating conditions and (2) use of cheaper and lower grades of fuels.

C. Electric Power

The electric power and lighting requirements for a 100-ton per day dehydration plant vary from 200 to 400 kilowatts. Incoming service is usually 440 volt, 3-phase. A standby generator is a good precaution against possible plant shut-downs due to curtailment of the normal power supply.

1/ Cf. Chapter 3 of Food Plant Sanitation, by M. E. Parker (New York, McGraw-Hill, 1948). See also: "Ways to save water in the food plant," by Irving Reichmann, "Correction of defects in water used for food manufacture," by H. V. Miles on pages 59-60 of the Institute of Food Technologists PROCEEDINGS, 5th Chicago, 1944.

Local Factors Affecting Plant Sanitation and Quality of Product

A. Atmosphere Pollution

During the course of vegetable or fruit dehydration, enormous quantities of air pass over the material being dehydrated. Airborne dust particles may contaminate the products. Small amounts will usually do no particular harm under normal operating practices. No food dehydration plant should be located in an area where noxious contaminants are present in the atmosphere.

B. Water Supply Pollution

Wastes and water disposal methods of nearby plants may affect the water supply. Milk processing, leather tanning, paper manufacturing, and metals processing can be some of the worst offenders.

C. Insects and Rodents

It is advisable to avoid establishing a dehydration plant in a locality known to be highly infested with insects and rodents because their presence indicates a general sanitation level unacceptable for food processing purposes. Many food and grain warehouses have these pests, and an infected neighboring warehouse can easily start a similar problem in the dehydration plant. Proper plant and warehouse construction, plus regular control measures, will help materially to minimize infestation problems.

Weather Conditions

The weather experienced during harvesting and processing seasons has some bearing in the selection of a good plant location. The following points are among those which should be considered:

A. Hampering of Harvesting Operations

Commodities such as carrots, beets, and cabbage are processed immediately after harvest. Weather conditions which seriously interrupt harvest of raw commodity may cause the plant to shut down.

B. Interference with Drying Operations

Areas which have high humidity many days during the processing season should not be favored for a plant location. On days of high humidity it is more difficult to produce low moisture products of satisfactory quality. If the plant must be located in an area of high atmospheric humidity, then provision must be made for dehumidification of at least that part of the air which performs the final drying operation.

Heat requirements for dryers using heated air are appreciably affected by outside air temperature. For example, when the outside air temperature is 75°F., a dryer operating at 175°F. must raise the air temperature 100°F. If the outside air temperature drops to 25°F. the air temperature must be raised 150°F. This requires roughly 50% more fuel and 50% more heating capacity than when raising the temperature 100°F. If the drying facilities are not designed for the low temperatures that will occur, product throughput will be reduced during such periods.

Waste Disposal or Utilization

A. Waste Disposal Problems

One of the biggest problems of a vegetable or fruit dehydration plant is disposal of its waste products. These wastes come principally from grading, washing, peeling, trimming, cutting, and blanching operations. A 100-ton per day plant will have as much as 15 to 35 tons of solid wastes and as much as 300,000 to 1,000,000 gallons of liquid wastes a day.

Disposal of the two phases (solid wastes and liquid wastes) depends on the products being processed, terrain and types of soil in the immediate area, proximity of surface streams or bodies of water, and sanitation regulations for the locality. Treatment of wastes prior to final disposal is usually classified as (1) mechanical, (2) biological, or (3) chemical. The first step is usually to separate the coarser solid waste from the liquid by mechanical screening. Subsequent treatment, utilization, or disposal methods are governed by a number of considerations.

Solid wastes are often used for stock-feed in the local area. Such disposal rarely affords any economic gain to the plant as the wastes are usually given in exchange for removal, or the plant may even have to pay for removal of the wastes. In some cases solid wastes are disposed by dumping in pits or on open ground sufficiently distant from the plant that wastes will not be a nuisance. These solid wastes may require treatment and handling that prevent odor-formation, vermin and rodent infestation, and contamination of adjacent lands and bodies of water.

Liquid wastes usually are run into sewers, streams, and drainage or irrigation canals, or are impounded or dispersed on open land. Some disposal practices are tolerated by communities only as temporary or emergency methods, and are subject to abatement measures at any time. Plants in isolated areas may have to provide and operate their own disposal units. Plants in areas served by public sewer lines may have a simple disposal problem for this liquid phase if the public system has sufficient capacity and versatility to handle loads imposed by the dehydration plant.

Wastes that are disposed of in sewage treatment plants can greatly disrupt the treatment processes in the sewage system because of excess quantities of solid matter, harmful chemicals from peeling or other operations, and clogging of lines from sediments -- especially starch from potatoes or sweetpotatoes. Cleaning and sanitizing agents used for maintaining plant cleanliness can complicate handling and disposal of plant wastes. They may adversely affect settling and flocculation of solids, as well as desired biological digestion, in sewage units. Some of these

surface-active materials have long-lasting, residual toxic effects. It may be necessary in such cases to divert water containing these washing and treating agents to a separate disposal unit.

Dumping of liquid waste in streams and drainage or irrigation canals depends on dilution of the waste to a level that is tolerable for that waterway. Volume of water for dilution, characteristics of that water, and the standards that must be maintained in down-stream areas are deciding factors.

The seasonal nature and high peak-loads of food processing plants have limited use of the above methods of disposal, and impounding or dispersal over land areas is increasing. Impounding or lagooning permits reduction of the load by biological action on solids, by evaporation, and by ground seepage. Wastes that are impounded may be dumped in streams when stream flow is high. Odor control by chemicals is usually necessary where impounded waters contain appreciable organic matter.

Dispersal over land areas may be accomplished by ditch or spray irrigation. The latter practice is increasing more rapidly because of lower labor requirements. Soil for this use should be permeable. A heavy cover crop is grown to prevent erosion and run-off and to maintain the permeable nature of the soil. Crops for harvesting are occasionally grown on the land, but usual practice has been to grow as heavy a cover crop as possible and to allow it to remain on the land.

Failure to provide satisfactory waste disposal has resulted in closing of many plants. Waste disposal problems for the plant should be discussed thoroughly with city, county, State, and Federal sanitation officials and their recommendations heeded. Most States require approval of plans for waste treatment systems.

B. Possible Utilization of Plant Wastes

General experience to date has been that utilization of dehydration plant wastes is limited. Such potentialities as exist should be investigated prior to establishment of a plant, as plans for utilization may affect design of the entire waste disposal system and may even affect plant location and processing operations.

The liquid phase is usually so dilute that its best value probably lies in returning it to the natural waters of the area or used for irrigation after any necessary treatment.

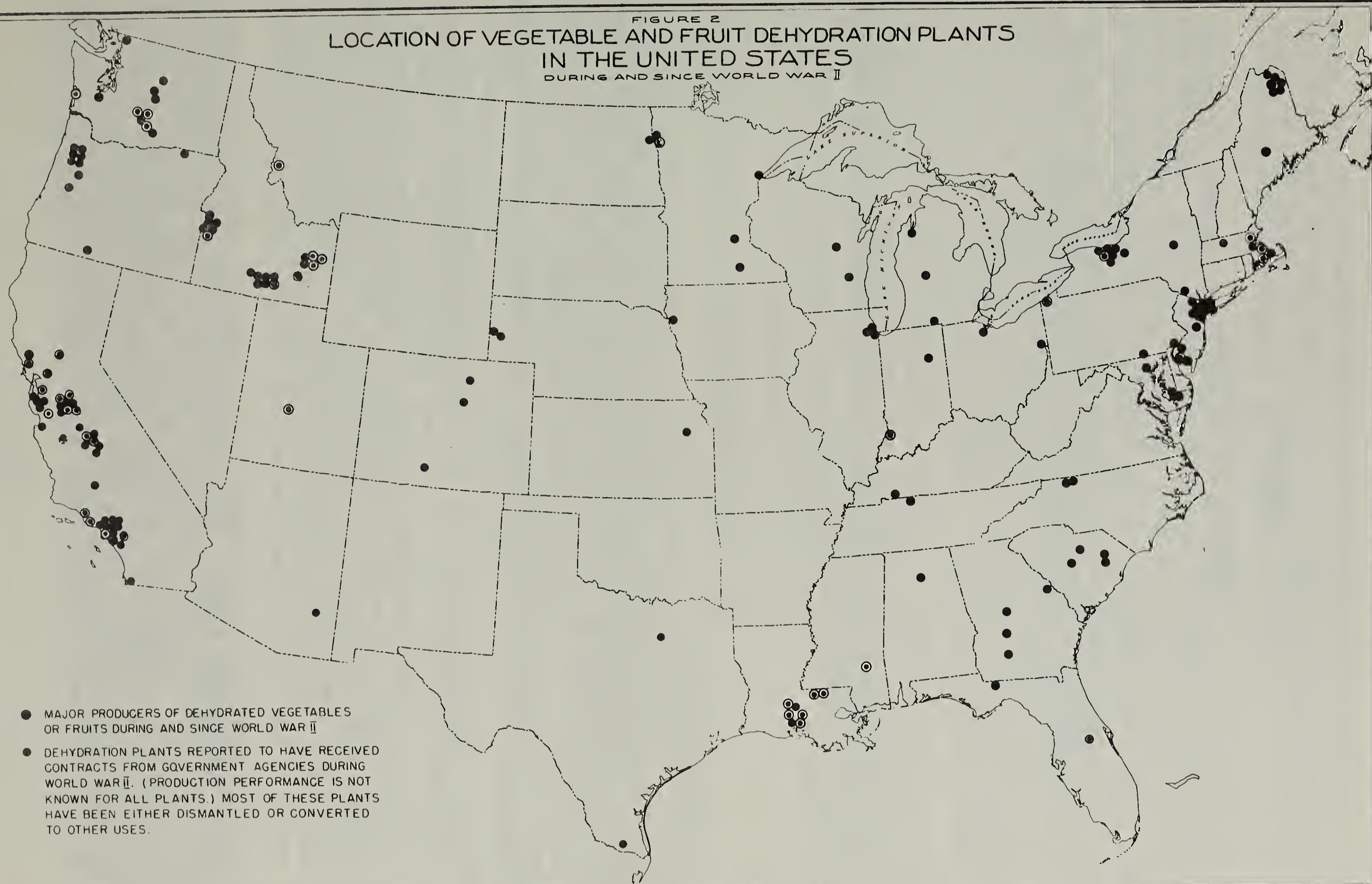
Solid waste material is most often used as stock feed, and there is also some recovery of starch from potato sort-outs. Manufacture of alcohol has some potential during an emergency.

Even under the most favorable conditions, only very large dehydration plants can hope to find byproduct processing feasible, because economic conversion processes can be accomplished only on a substantial scale of operation. Furthermore, the low value of waste materials makes it mandatory that the byproduct facilities be quite near the dehydration plant in order to minimize transportation and handling costs.

FIGURE 2

LOCATION OF VEGETABLE AND FRUIT DEHYDRATION PLANTS IN THE UNITED STATES

DURING AND SINCE WORLD WAR II



CHAPTER VI

SUPPLY OF RAW MATERIAL

Of the many factors that contribute to the success of a dehydration plant, the availability of a constant and suitable supply of raw material is one of the most important. Unfortunately, the importance of this factor was often overlooked or ignored in the establishment of some dehydration plants during World War II. There were many failures of plants because the available raw material was not suitable for dehydration, or because sufficient quantities of raw material could not be obtained regularly or at satisfactory prices.

Areas that have been important in supplying raw material for vegetable and fruit dehydration during and since World War II are shown in Figure 3. Reference to Figures 2 and 3 shows the relation of these various commodity growing areas to the location of existing dehydration plants.

Raw Material Requirements

A. Quality Considerations

Generally, the preferred raw material is one that will produce a dehydrated product which, after storage, readily reconstitutes to a food having good flavor, texture, appearance, and nutritional qualities. The end product can be no better than the original material, so it is essential that the raw material be top quality for the intended use. The desired characteristics for dehydration of each of the commodities considered are outlined in Chapter VIII.

1) Varietal characteristics. Not all varieties of vegetables and fruits make good dehydrated products, nor is a variety which has proved best when grown in one location necessarily superior, or even acceptable, when grown in another part of the country. A variety of vegetable or fruit, known to be suitable for dehydration, must be grown in an area to which it is adaptable and under conditions which give satisfactory yields and quality. The prospective dehydrator must make a thorough investigation of the raw material available in a proposed area and be assured that it has the desired characteristics for dehydration.

2) Over-all shrinkage ratio. The over-all shrinkage ratio, or the ratio of the weight of incoming raw material to the weight of salable finished product packaged, is one of the most important factors determining unit cost of production. Many things affect this shrinkage ratio, including both raw material and processing considerations. Among those factors that concern raw material are: (a) moisture content of raw commodity; (b) presence of undesirable material such as rots, bruised portions, thick skins, deep eyes requiring considerable

trimming, etc.: (c) chemical composition which may affect quality of finished product and result in excessive rejects of dehydrated products, and (d) size and shape of the individual units (small and misshapen units have higher proportionate peeling, trimming, and inspection losses).

3) Maturity. Vegetables and fruits for dehydration must be of proper and uniform maturity. Over-mature commodities may be woody, fibrous, mushy, and generally lacking in quality. Immature commodites may be small in size, low in solids content and desired flavoring power, and otherwise unsuitable.

4) Cultural practices and growing conditions. Proper cultural practices, prudent use of water, fertilizers, and insecticides, and proper cultivation are necessary to obtain the desired quality of raw material.

5) Harvesting and handling raw commodity. In order to assure receipt at the plant of raw material of optimum quality, it must be harvested, sacked or boxed, cured, stored, and hauled according to approved practices.

The dehydrator who has assured himself of a suitable supply of raw material has taken a major step toward the successful operation of his dehydration plant. Many dehydrators have instituted their own growing programs in order to supplement their regular sources of supply, thus better assuring themselves of an uninterrupted plant operation as well as a raw material of known quality.

B. Quantity Considerations

1) Length of harvest season. A producing area with a long period of availability of raw commodity is to be preferred. Some vegetables, for example, carrots and cabbage, are harvested practically the year around in certain sections of the country. Location of a plant in these areas is preferred over locations in an area where the harvest season is of short duration.

Commodities such as potatoes and sweetpotatoes are available from storage for several months during the year in addition to the period of harvest. Areas that have suitable storage facilities and follow desired curing and storage practices are to be preferred.

2) Multiproduct operations. Some thought might be given to running the dehydration plant on more than one commodity. Among the combinations of raw commodites that might be processed in the same plant are the following: (a) carrots and potatoes; (b) onions, peppers, and garlic; and (c) beets and potatoes.

A plant located most favorably for one vegetable or fruit may have to process a second commodity under circumstances that are not as favorable. For example, high hauling costs may be incurred to obtain a supply of the second commodity from a distant growing area, or the quality and quantity of the raw commodity obtainable locally may be somewhat less than desirable. The higher production costs likely to be incurred on the commodities processed during off-season may be offset by the reduced indirect and overhead unit charges on the total yearly production.

Techniques of Procurement

The production of perishable foods in the United States is normally geared to peacetime domestic and export demands. If a sudden emergency develops which causes an unusual demand for a food, the supply and demand forces may become drastically unbalanced. The logical method for avoiding the disruption of the economy is to encourage an increased production to the extent needed to cover the emergency demands. This is not always a practical solution, however, especially during the first year of such an emergency. Until the required increase in production can be built up, some dislocation of established lines of distribution and price relationships may be inevitable. Under such conditions the operator who has contracted to deliver a dehydrated product should, as promptly as possible, contract with growers to supply all or a substantial part of the raw material he will need to meet his commitment. One means for meeting emergency needs is to encourage growers to divert acreage which has been devoted previously to crops that are less important in wartime.

During World War II various methods of purchasing raw material were used by different operators handling identical products. Some operators depended upon supplies from acreage contracted by the particular plant for its exclusive use, while others depended solely upon open-market purchases of fresh commodities. These two general methods of procurement are discussed below.

A. Contracting for Future Supply

The practice of contracting for future delivery of farm commodities is very widespread in the United States for supplying food processors. This has proved to be the most practical and satisfactory method for procuring raw material for dehydration.

The dehydration plant operator who is already established in the business of handling the fresh commodity, whether as a fresh-market packer or shipper, warehouseman, or distributor, will be in a particularly advantageous position. He will have dependable contacts with growers and will be familiar with local contracting customs and problems.

The processor should develop a reputation for integrity and must promptly make good on all his obligations, especially his obligations to growers. He should take care that growers with whom he deals have a similar reputation. Both parties also should have sufficient financial resources to meet their obligations even if certain contracts result in losses.

A grower-processor contract has definite advantages to both parties. The advantages to the grower are:

1) A sure market or outlet for the entire crop.

2) A specified price which should assure a reasonable profit.

3) Assistance in obtaining priorities, during emergency conditions, for critical supplies and equipment. During World War II every county of any agricultural importance in the United States had an "Agricultural War Board"

to pass on applications for draft deferments, farm machine priorities, etc. A contract showing production of an essential crop was the best evidence for obtaining favorable action from this board.

4) Aid in getting credit for financing the crop. Banks and production credit associations usually welcome reasonable applications for loans from farmers with contracts.

5) The benefits of research projects conducted by processors as affecting cultural practices and improved varieties.

The advantages of these contracts to the processor are:

1) Assurance of a raw material supply of desired variety, quality, and quantity delivered according to a schedule that helps assure his meeting Military contract requirements.

2) Assurance of a fixed price for raw material independent of market prices at time of harvest.

3) Assurance of a sound basis for planning plant operations, deliveries of finished products, and financing requirements.

Often the grower-processor contract stipulates that the buyer (processor) is to furnish the necessary seed. This practice has many advantages. Some growers seem to have a greater respect for the contract when the purchaser has an investment or risk in the crop. The processor is often better situated to obtain seed in time of scarcity and may be able to obtain better quality seed than the grower. With the seed supply under control of the processor, production of the desired varieties is assured, a somewhat better control of planting schedules is possible, and still more important, a steady flow of raw material into the dehydration plant thus can better be maintained.

The custom that prevailed during World War II was to contract for the total yield from fields of specified acreage rather than for a specified weight. Because of variable yields, it is difficult for operators to contract for specified weights.

The following points should be covered in a grower-processor contract in addition to the general content, form, signatures, etc., of any valid contract:

1) Map showing location of field with a legal description of the property and total number of acres involved.

2) Variety and source of seed; if seed is furnished by buyer, state the price charged to grower and terms of payment.

3) Date of planting with or without definite substitute dates (based upon desired harvesting and delivery dates).

4) Standards of maturity used to determine harvesting time and who decides when crop is ready to harvest.

5) Who decides the rate of harvest and method of harvest (in case there are several alternate methods).

6) Point of delivery, whether roadside, field, shipping point, or dehydration plant.

7) Weighing to be done at a public weighmaster and only certified weights to be used (duplicate copies to each party), or weighing to be done at plant.

8) Quality standards (minimum or grades) and allowances or tolerances for dirt, injury to the commodity, small sizes, etc.

9) How inspection and grading are to be done and by whom (duplicate copies of these certificates to both parties).

10) Minimum and maximum quantities to be delivered to plant.

11) Price per unit (according to grade if mutually agreeable, with or without premium for low shrinkage commodities, or perhaps based on average solids content of fresh commodity).

12) Adjustment in case harvest yields greatly exceed that normally expected or that specified in contract.

13) Responsibility in case of delay and/or deterioration of commodities in transit from farm to plant.

14) Cancellation rights of both parties in case of fire, strikes, flood, and other acts beyond control of the parties.

15) Rights of grower as a sub-contractor in case the prime contract held by the processor is cancelled or terminated by the Government.

16) Transferability of contract.

17) Methods for handling disputes.

Typical contracts can be obtained from the various associations of growers, canners, and freezers. The College of Agriculture and the Agricultural Experiment Station of the University of Wisconsin, Madison, have done considerable research on problems of contracting with farmers supplying processing plants.

B. Open-Market Purchases

Operators who do not contract for future supplies of raw commodities must depend on open-market purchases. Such practices often lead to inefficient use of plant and labor and cause delays or non-fulfillment of contracts for delivery of dehydrated product.

Vegetable production is quite variable from year to year, because the number of acres planted is readily changed in response to market conditions and yields per acre fluctuate. Thus dependence upon open-market purchases of fresh vegetables can be doubly precarious from a price standpoint. It is entirely possible that there may not be sufficient raw commodity available at any price.

The amount of fresh fruit depends upon yields since the acreage is relatively fixed. Fruit price fluctuations from season to season may be even wider than in the case of vegetables; an increase in demand which happens to coincide with a short crop will bring about an altogether disproportionate increase in price. The dehydrator runs grave production and financial risks if he relies upon open-market purchase for more than a minor part of his needs.

Processors who normally operate on a contract basis use open-market purchases and sales to balance their supplies to processing requirements. In case of delays in delivery of raw material caused by late planting, unseasonal weather, low yields, or other factors, spot purchases of entire crops in fields or storage can be made if prices are within practical limits. In this way a plant may be kept in operation that might otherwise be halted.

Open-market sales can help dispose of excess fresh commodities resulting when the yield per acre on contracted fields is much larger than anticipated, or when abnormal peak yields occur due to late plantings catching up with earlier plantings. Such surpluses might be sold on the open-market to shippers, other processors, or commission merchants in nearby markets.

The practice of using open-market purchases and sales as a supplement to contract purchases is recommended, but the use of open-market purchases as the principal method of obtaining all needed raw material is not a sound basis for operating a dehydration plant.

C. Special Problems in Procurement

One of the most difficult problems of raw commodity procurement is to find dependable and interested growers. Suggested sources of information for locating qualified growers are:

1) Agricultural supply concerns, such as dealers in equipment, fertilizers, seeds, and insecticides

2) County Agricultural Agents (sometimes known as County Agents, Farm Advisors, County Farm Agents, etc.)

3) Local, State, or Federal agricultural agencies

4) Rural financing organizations in the areas, such as Production Credit Associations

5) Farmer organizations

The avoidance of sub-marginal growers is a major problem to be solved by procuring agents. Some growers may be lacking in general ability, finances, and production resources. Undependable growers cause continuous anxiety and trouble, and may ultimately cause either shortages or surpluses in raw material supply. As a general rule, the best growers are those who have been successful in past years. This is usually reflected in the condition of their farms, equipment, and homes, and by their financial stability.

Some growers will be tempted and a few will even break their contracts if market prices are much higher at harvest time than the original contract price, even though the contract price affords a profit. A certain amount of vigilance on the part of the field agent is necessary in dealing with undependable growers. Cases have been known of growers selling part or all of a crop grown under contract. Cases have also been known of growers under contract attempting to deliver a neighbor's or a relative's crop as part of their contract when open-market prices are very low at the time of harvest.

Poor cultural practices during the growing season will materially affect both the quality and the quantity of the harvested commodity. The field agent must be constantly alert to prevent such bad practices, and he must be tactful and professionally skillful to achieve the overall objectives of good crop yields having acceptable quality. The growers should be warned against using some of the recently introduced insecticides, because some have been found to impart objectional odors and flavors to processed foods with many of the adverse effects appearing only after a period of storage.

The degree of maturity a commodity should attain is often a point of disagreement between the grower and the field agent. The grower wants the maximum tonnage possible, which usually means over-maturity. The processor wants top-grade dehydration quality, which usually means harvesting in the early stages of maturity. Over-maturity in such vegetables as cabbage, carrots, and beets causes serious defects in the dried products. To assure the proper quality and to maintain desired delivery schedules, contracts should be written so that the processor, through his field agent, is the sole judge as to the time and rate of harvesting.

In spite of all precautions that can be taken by a good field agent in contracting for and supervising the procurement of raw commodities, he will always be faced with the problem of maintaining a constant supply of raw material to the processing line. Commodities that cannot be stored for a long period of time present the most acute problem. Weather conditions make the final determination of when the commodity is ready for harvest. It is important, therefore, that the field agent has all possible information about crop conditions and weather forecasts to assist him in scheduling harvest to match plant processing capacity so far as is feasible.

D. Need for Competent Field Agents

It is no easy task to plan and develop a source of raw material that will attain optimum quality at the right period of time, and that will yield the desired quantity over the desired period of operation. The successful operation of a dehydration plant requires that these plans be made many months and sometimes years in advance, particularly when new areas are to be brought into production. Some of the problems that may be encountered are those connected with (1) education of growers in the production of a new crop, (2) proper crop rotation and other cultural practices, (3) procurement of an adequate supply of suitable seed, (4) assurance that sufficient water is available for irrigation (if needed), and (5) selection of a suitable soil.

A field agent has the key role in such work. The average grower leans heavily upon the advice of the field agent regarding many of the operations involved in producing the contracted crop, and the agent should be ready and willing to assist in an advisory capacity at any time.

An assistant field agent should be employed in the larger plants operating over a very long season. The field agent would primarily be responsible for contract negotiations with growers and for supervising planting and growing of crops. The assistant could determine rate of harvesting and shipping in order to coordinate raw material supply with plant requirements. He could also be responsible for checking maturity, freedom from disease and insect-infestation, and other factors of quality of the harvested crop.

E. Licenses and Inspections

There is an optional non-regulatory Federal-State inspection service that is available to dehydration plants in nearly all districts which commercially produce vegetables and fruits in the United States. This is known as "Shipping Point Inspection Service". Under this service a Federally trained and licensed inspector can be obtained for the continuous inspection of all raw material coming into the plant. He will inspect upon the basis of United States Standard for grade and size, and upon any additional specifications included in the grower's contract for which the inspector is equipped. Because speed is essential in inspecting raw material so that deliveries to the plant will not be impeded, proper equipment should be provided to facilitate the work of the inspector. 1/

Specifications for several of the dehydrated vegetables and fruits require that raw material used shall meet certain United States Standards. In order to insure that raw materials conform with these standards, it is recommended that the Federal-State inspection service, or other impartial agency, be utilized whenever raw commodities are being received for production under a Federal Government contract.

F. Suggestions for Helping Meet National Emergency Needs

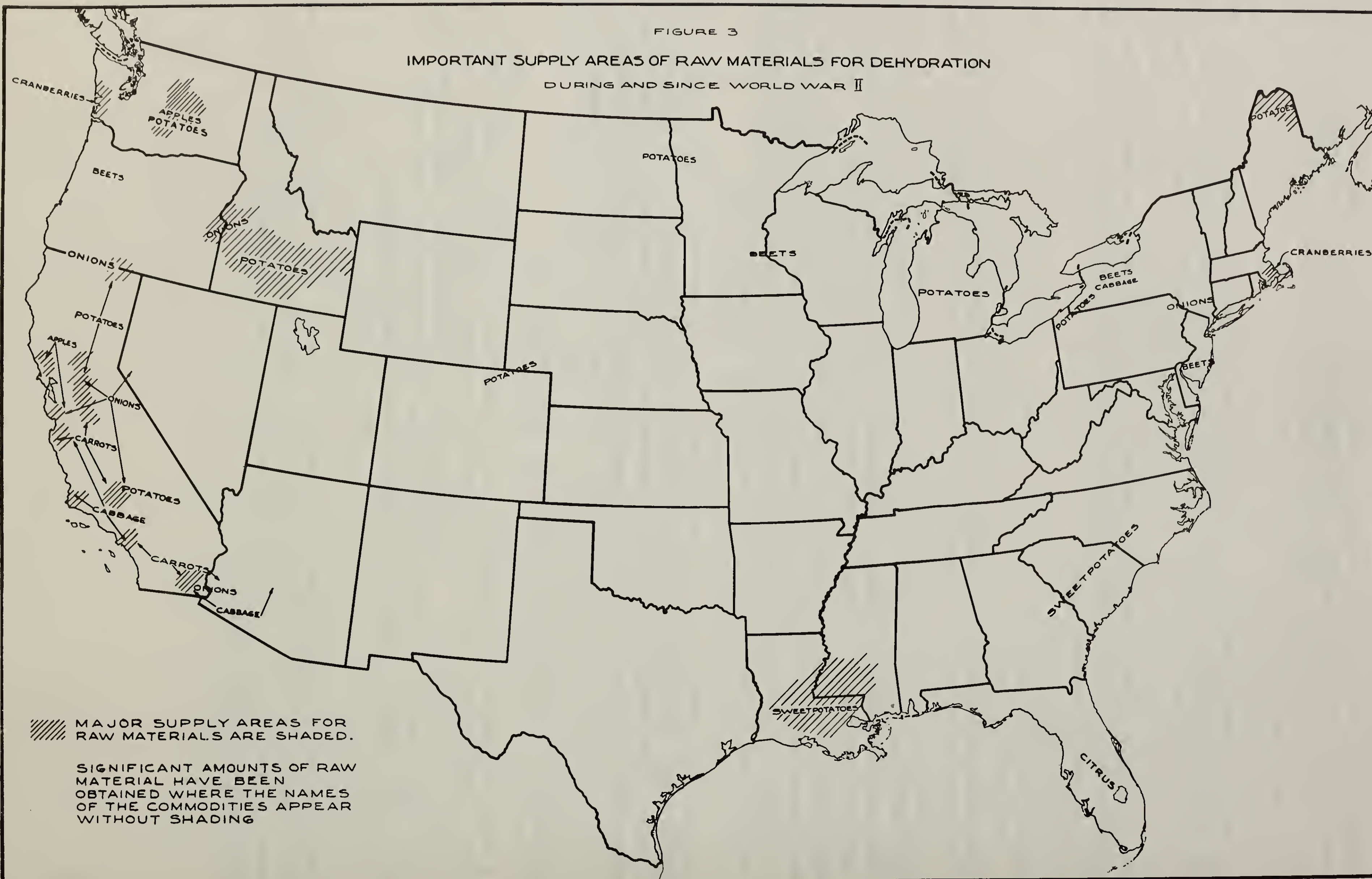
The long time required to arrange for raw commodity procurement makes it mandatory that proper planning be done by all parties concerned well in advance of Government needs of dehydrated products. In many growing areas and for some crops from six months to a year may be required between time the dehydrator contracts with the growers and the time he starts delivery of dehydrated products.

1/ To inquire about such inspection service, contact the Fresh Products Standardization and Inspection Branch, Fruit and Vegetable Division, Agricultural Marketing Service, U.S. Department of Agriculture, Washington 25, D. C., or a local office of the agency.

FIGURE 3

IMPORTANT SUPPLY AREAS OF RAW MATERIALS FOR DEHYDRATION

DURING AND SINCE WORLD WAR II



MAJOR SUPPLY AREAS FOR RAW MATERIALS ARE SHADED.

SIGNIFICANT AMOUNTS OF RAW MATERIAL HAVE BEEN OBTAINED WHERE THE NAMES OF THE COMMODITIES APPEAR WITHOUT SHADING

CHAPTER VII

CHOICE OF PLANT SIZE

Selection of scale of operation for a food processing plant is usually based largely upon economic factors. In a peace-time economy low operating costs are essential to profitable operation. In an emergency period, however, factors other than economic must also be carefully considered in deciding the scale of operation. Many of these factors cannot be reduced to numerical terms, and the determination of their relative importance becomes largely a matter of judgment.

There is no such thing as the most efficient plant or the proper scale of operation for any given commodity. The best plant in one situation may be unsuitable under other conditions. The same basic principles must be used in appraising each situation, however. The following discussion is concerned mainly with a consideraion of various factors that must be taken into account by a prospective dehydrator in deciding on a scale of operation.

Size of plant, in an emergency period, should be determined in the light of:

1) Emergency needs

2) Resources of an area

3) Management and technologic needs and availability

4) Equipment needs and availability

5) Initial plant cost

6) Production costs

7) Anticipated length of emergency

8) Use of plant after emergency

Emergency Needs

Timely production of the required quantity and quality of end product is the first essential. Plant sizes must be chosen that will insure this result.

It is not consistent with good military planning to allow concentration of effort in only a few very large plants. Procurement contracts must be spread among enough plants so that loss or poor operation of one or two would not seriously jeopardize the whole procurement effort. For example, the anticipated Government procurement

goal for dehydrated onions for 1945-46 was 23 million pounds. It would take 10 onion plants handling 100 tons of raw onions a day, during a six-month season, to meet this requirement. The loss of one or two of these plants through fire, sabotage, etc., therefore, would not be disastrous. Present operating plants are somewhat larger than this size.

The total number of plants required should not be so great as to complicate Government procurement. This naturally places a top limit on the number of plants which would be practical to operate. A balance must be achieved, therefore, between a rather large number of plants for security reasons, and a small number of plants for simplicity in procurement. Other factors, however, must also be considered.

It may be difficult for very small plants to maintain production of dehydrated vegetables or fruits of satisfactory quality. In fact, this was proved during World War II when Government procurement agencies had unfortunate experiences in contracting with some small dehydrators.

A small dehydrator may experience difficulty in obtaining a satisfactory supply of raw commodity. If his operation is not of sufficient size to permit contracting in advance with large commercial growers, the small dehydrator must rely on the open market or upon small-scale growers whose cultural practices may vary widely. If the dehydrator has inadequate control over raw material supply, quality of end-product will suffer accordingly.

Adquate equipment and controls must be installed to permit the production of a quality product, and consistent and careful operating procedures must be adopted and enforced. It is doubtful if very small dehydrators can always afford to provide these necessary requisites.

Medium and large size plants should be able to maintain a constant production of satisfactory quality product, provided, of course, that the factors for quality production are present. It is difficult to specify a dividing line between an adequate size plant and one too small. It is probable, however, that plants processing more than 60 to 70 tons of raw commodity per day may not experience any serious difficulty in producing quality products for reasons relating only to plant size.

During World War II, the record among the small plants was variable. Failures during the war period were almost entirely of plants of capacities less than 100 tons per day. This, of course was not caused so much by small sizes of plants as it was by lack of proper management, planning, and sufficient financial backing. Many prospective operators seriously underestimated their capital requirements. Nevertheless, many small and medium plants operated efficiently and successfully. It is likely in any future emergency, however, that the smallest plants will be larger than in the past. During the war period many plants of 25 to 50 tons a day were in operation. Since then minimum size has increased to around 60 to 70 tons a day for dehydrated vegetables and fruits that have sufficient market demand.

During World War II the greatest number of new plants established were of small to medium size. Only five or six very large plants were built. These large plants, however, had excellent production records and contributed substantially to the total production of dehydrated foods.

Newcomers in the dehydration field may favor building plants ranging in capacities from perhaps 50 to over 100 tons a day of raw material. After satisfactory operation of these plants has been attained, the operator could more confidently expand capacity if necessary. Presently established companies, with their personnel of proved experience in successful operation, will be in the best position to construct large plants.

Resources of an Area

Ability of an area to supply raw material, labor, utilities, etc., for a dehydration plant must be considered in the choice of plant size. No plant should be built so large that it cannot readily secure enough suitable raw material or a sufficient number of employees. Present dehydration plants are operating in areas that can support any reasonable size of plant. The problems of plant size would be encountered only if a prospective dehydrator considers locating a plant elsewhere.

If there is any doubt that an area has sufficient resources to operate a plant of economic size, that area should be avoided. The usual variations that occur in the growing of raw commodity and the possible competition from other industries or plants for labor supply make any marginal area clearly undesirable for the establishment of any size of dehydration plant.

Management and Technologic Needs and Availability

An organization capable of paying the most for management and technologic skills is in a favorable position to obtain the best talents available. Larger plants, therefore, are most favored in this respect.

Some small plants have excellent management and technical staffs. When smaller plants cannot meet the salaries offered by large plants, some other incentives must be available such as advantages of a particular location and desire of the individual to work in a smaller plant. It would be inadvisable for small plants to attempt to hire all of the personnel indicated on the organization chart in Chapter IV. Small plants, then would need multiple-function personnel. Success of such plants, therefore, will depend upon their obtaining men with varied capabilities.

Most of the skills specified in the aforementioned organization chart could be provided in medium size plants without imposing a serious financial burden upon the plant. Diverse abilities of key personnel, however, will still be important in determining the success of these plants, because some individuals will be performing more than one function.

Only large plants of over 150 - 200 tons a day capacity will be fully able to staff the plant with specialists for each important function. The resulting delegation of authority and responsibility to qualified personnel will lighten the load on top management people and allow them to concentrate on important general management functions.

Because supply of experienced management and technical personnel is limited in the field of dehydration, very large plants should be able to make most efficient utilization of available skills. Present dehydrators could readily build and operate large new plants by using experienced key personnel now on their staffs. Newcomers would probably be compelled to build medium size plants, in part because their successful operation might be achieved with fewer management and technical employees.

Equipment Needs and Availability

This factor is important mainly in limiting plant sizes within certain ranges and in setting a minimum size.

Some items of equipment in a dehydration plant are installed in multiples of the basic unit. These include dryers, slicers and dicers, certain types of washers and graders, automatic tray-stackers, and tray unloaders. Some items are available in only a limited number of sizes; and one item, a certain make of dicer, is manufactured in only one size.

A plant is usually scaled to the capacity of the dryer, the most costly item of equipment. Plant capacity will be dependent, then, upon the number of dryer units installed. For example, a single dryer unit may have a capacity of 25 tons of prepared material a day, so plant capacity will be nominally in multiples of 25.

It is not always possible to obtain all other equipment items in a plant to match exactly the capacity of the dryers. The alternative is to get these items with somewhat greater capacity. This has an advantage, however. Having excess capacity in this other equipment will make it possible to feed a steady and optimum rate of prepared material to the dryers, in spite of variations in raw commodity characteristics and preparation efficiency.

The smaller plants will have greater difficulty in properly matching available equipment units to give a production line that is properly balanced, free from "bottlenecks" that prevent most efficient use of production facilities.

If a shortage of certain construction materials occurs, the most expedient use of these materials can be made in larger plants. Capacity of some items of equipment can be doubled while weight of construction materials used may increase only about 50%. Critical materials should be used efficiently and not be dispersed ineffectively over a large number of small plants. Thus, with a given quantity of critical construction material, production potential would be greater if that material were put into large plants.

Initial Plant Cost

In planning a plant, prospective dehydrators may desire to consider a range of plant sizes. Accurate cost information for all possible plant sizes is not readily available. The following discussion indicates how one would obtain rough estimates of costs of various sizes, using methods and data which may be available.

Chilton 1/ showed that for process plants, the following relationships exist between various plant sizes and costs:

$$\frac{\text{Cost of plant, size A}}{\text{Cost of plant, size B}} = \left[\frac{\text{Capacity, plant A}}{\text{Capacity, plant B}}\right]^{0.6}$$

It is believed that costs for construction of plants for dehydration may deviate somewhat from this rule because of the multiple equipment units required in such plants as size is scaled upward. A revised formula similar to the one above may be derived specifically for dehydration plants. For this purpose we may use other cost data 2/ which shows the estimated costs for constructing various sizes of dehydration plants in 1943.

From these data one may derive a ratio similar to the Chilton formula, which we may apply to dehydration plants:

$$\frac{\text{Cost of plant, size A}}{\text{Cost of plant, size B}} = \left[\frac{\text{Capacity, plant A}}{\text{Capacity, plant B}}\right]^{0.8}$$

This formula may be used, as shown below, for calculating the approximate cost of constructing a plant of desired size when cost of another size is known.

The first two columns of the following tabulation give specific values calculated by the formula. The last two columns show an example in which the cost of a 100-ton per day plant is known to be $500,000.

Ratio of Plant Sizes	Estimated Ratio of Plant Costs	Plant Size (tons per day)	Estimated Construction Cost
.25	.33	25	$165,000
.50	.6	50	300,000
1.00	1.0	100	500,000
1.50	1.4	150	700,000
2.00	1.7	200	850,000

A factor that tends to keep investment costs of very small plants in line with this empirical formula is that smaller plants rely largely on hand labor to do many operations that are done mechanically in larger plants. Thus investment costs are kept lower than would otherwise be possible. Any change to manual operation, however, is made at the expense of production cost which will be correspondingly greater in smaller plants.

1/ Cf.: " 'Six-tenths factor' applies to complete plant costs," by C. H. Chilton. CHEMICAL ENGINEERING 57(4):112-14, April 1950.

2/ Cf.: Page 17 of Vegetable and Fruit Dehydration - a Manual for Plant Operators, prepared by U. S. Bureau of Agricultural and Industrial Chemistry (1944) (U. S. Department of Agriculture Miscellaneous Publication 540)

Production Costs

Differences in operating costs between plants of the same size are likely to be greater than differences in cost between efficiently operated plants of various sizes. This assumes, of course, that sizes considered are beyond the clearly uneconomical small sizes.

Many factors not entirely related to plant size contribute to successful and profitable operation of a dehydration plant. Among the most important are the following:

1) High yield of finished product from raw material. This factor is almost independent of plant size. A medium size plant can obtain yields comparable to those of larger plants. Quality of the raw material procured and manner in which a plant is operated largely determine the overall-shrinkage ratio. Both of these elements are closely related to management and technologic skills rather than to plant size.

2) High throughput. A plant must operate continuously at or near capacity for most profitable operation. Any size plant can suffer from lack of raw material, shut-downs, etc. This factor, also, is largely unrelated to plant size.

3) Efficient labor utilization. Efficient utilization of labor is partly related to plant size. Labor requirements for such operations as trimming, coring, and inspecting are almost directly related to throughput, and labor efficiency in these operations is largely a matter of good management, training, and morale. Perhaps half of the direct labor in a plant is independent of plant size, and the other half is only partially dependent on plant size.

The three factors listed above are so vitally important in successful operation that plants of any size failing in these respects will certainly fail in total. Inasmuch as large plants do not have a monopoly on these factors, properly planned and well managed smaller sized plants can operate successfully and compete with larger plants.

It is important that a newcomer to dehydration build a plant of a size he can operate efficiently. If he builds a plant larger than he can handle properly, his costs will be greater than would have been experienced in a smaller but efficiently operated plant.

Anticipated Length of Emergency

The longer the emergency, the larger the plants that may be justified. Anyone investigating the dehydration business probably would be hesitant to invest in a large plant, to the extent of millions of dollars, if the emergency promised to be of short duration.

In any emergency, Government needs will be initially supplied from the present sources of dehydrated foods, even though some dislocation of the civilian supply and demand relationships may temporarily result. Additional requirements will first be met by more intensive use of existing plants (stepped-up production rates and round-the-clock operation over longer operating seasons) and by expansion of present facilities. Smaller plants could be quickly built in various advantageous locations to fulfill further the short-term needs, without severely disturbing economic balances.

Use of Plant After Emergency

The prospective dehydrator, in choosing a plant size, must look ahead to see what the prospects are for the plant after the emergency. If a peace-time market may exist for the output from the plant of given capacity, the operator would be hesitant to build a larger plant with private funds.

If no use for the building and equipment as food processing plant appears likely, only salvage value of the facilities will be realized. A building of a size suitable for other uses must be considered in keeping with resources and capabilities of the area.

CHAPTER VIII

PRODUCT SPECIFICATIONS AND BASIC PROCESSING STEPS

Military procurements of dehydrated vegetables and fruits are usually based upon Specifications or Purchase Descriptions. Basically, the intent of these two documents is the same, to describe an item to be purchased. Federal and Military Specifications are official documents issued for commodities for which purchase requirements have been standardized. Specifications are amended when deemed necessary or may be modified to meet specific requirements in a particular purchase. Purchase Descriptions are documents designed to cover items being purchased for perhaps the first time and for which requirements have not been definitely established.

Specifications and Purchase Descriptions describe the product wanted and stipulate raw material, process, and package requisites. Each prospective supplier of these foods must study the Specifications carefully to insure that he is bidding on the precise item wanted. Military acceptance of the product is dependent upon the analyses of samples to indicate their conformance to requirements.

This chapter contains brief summaries of Military requirements for most of the dehydrated vegetables and fruits for which Specifications and Purchase Descriptions have been issued to date. The excerpts are primarily direct quotes from descriptive purchase documents. Because requirements change from time to time and new ones are issued, each prospective supplier should inquire to determine the latest revisions. He should also obtain copies of Specifications and Purchase Descriptions as of the date of printing this Handbook.

Included in the respective discussions are statements indicating major areas in which the commodities were dehydrated during World War II. Presumably, these may be taken to indicate favorable areas for any future expansion.

Flow sheets showing major processing steps are given for each commodity. These indicate general types of equipment needed. Prospective dehydrators must obtain a great deal of additional specific process and equipment information before they are in a fair position to consider seriously a venture into this field.

List of Specifications and Purchase Descriptions Summarized in This Chapter

Product	Current Specifications or Purchase Descriptions
Apples, Dehydrated (Style I, pie pieces; Style II, sauce pieces)	Z-A-612a (9 October 1957)
Beans, Green, Dehydrated (Style 1, cross cut; Style 2, French cut)	MIL-B-35011 (19 December 1955)
Beets, Dehydrated (Type 1, diced; Type II, julienne)	MIL-B-3024 (3 August 1949)
Cabbage, Dehydrated (Shreds)	MIL-C-826 (27 July 1949)
Carrots, Dehydrated (Type I, diced; Type II, julienne)	MIL-C-839 (28 July 1949)
Cranberries, Dehydrated (Type I, powdered; Type II, sliced; Type III, whole)	MIL-C-827A (4 September 1951)
Juice, Grapefruit, Dehydrated (Powder)	Pur. Des. (2 April 1956)
Juice, Orange, Dehydrated (Powder)	Pur. Des. (3 April 1956)
Onions, Dehydrated (Type I, flaked; Type III, sliced)	JJJ-O-533 (8 August 1956)
Peas, Green, Sweet, Dehydrated	Pur. Des. (1955)
Potatoes, Sweet, Dehydrated (Type I, sliced; Type II, diced; Type III, julienne)	MIL-P-3025 (30 November 1949)
Potatoes, White, Dehydrated (Type I, diced; Type II, julienne Type IV, Class 1, granules)	MIL-P-1073A (12 December 1950)

Apples, Dehydrated
Style I, Pie Pieces; Style II, Sauce Pieces

Applicable Specification: Z-A-612a, issued on 9 October 1957.

Raw material: Clean, sound, fresh or previously dried apples of suitable varieties for dehydrating, and unless otherwise specified, shall have been prepared from apples of the latest crop.

Major dehydration areas during World War II: California and Washington.

Piece size of product: (Style I), pie pieces, 3/16" or less in thickness x 3/4" or more in length; (Style II), sauce pieces, pass through 0.446" square openings.

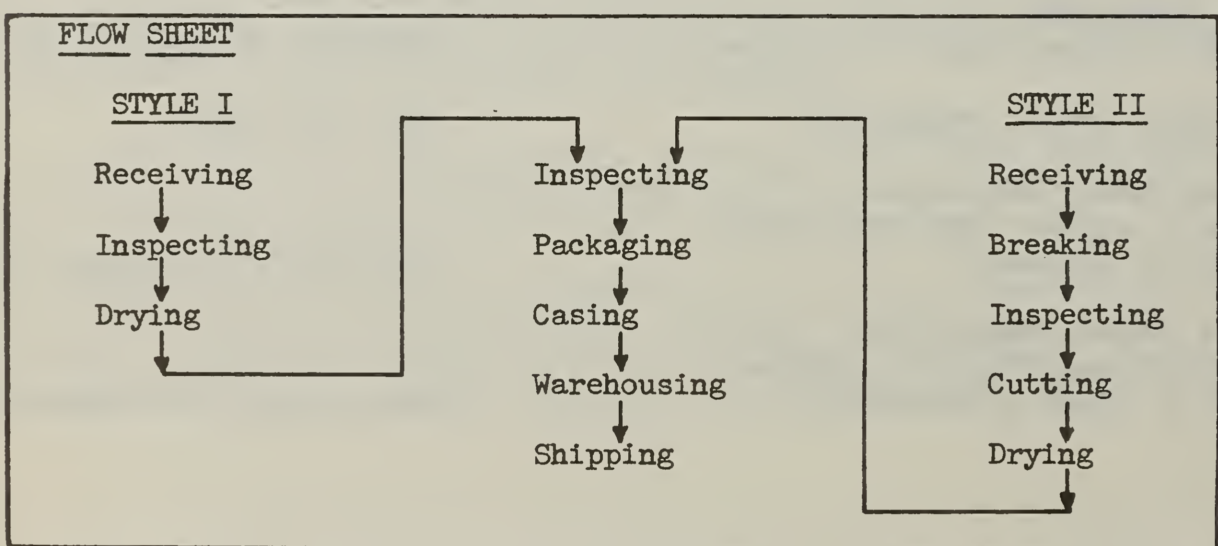
Finished product requirements: Normal flavor and odor, good color, reasonably uniform in size, practically free from defects, and good texture.

Moisture content of product: Not over 2.5%.

Sulfur dioxide content: 200 to 500 ppm.

Packaging: Pie pieces, 2 lbs. per No. 10 can; sauce pieces, 2-1/4 lb. per No. 10 can.

Defect tolerances: Pie pieces, not more than 10% by weight may be damaged by pieces of peel, bruises or other discoloration, bitter pit or corky tissue, water core, other means, calyxes, and stems, and provided not more than 1% by weight may be damaged by calyxes and stems; for sauce pieces the respective figures are 5% and 0.5%.



Beans, Green, Dehydrated
Style 1, Cross Cut; Style 2, French Cut

Applicable Specification: MIL-B-35011, issued on 19 December 1955.

Raw material: Seeds in early stages of development, tender, not fibrous; beans shall be fully fleshed, graded to eliminate sizes other than 4's and 5's.

Major dehydration areas during World War II: None.

Piece size before drying: (Style 1), 1/2" segments; or (Style 2), 1-1/2" - 2" segments sliced lengthwise.

Finished product requirements: Good, uniform, dark green color, free from haylike, scorched, rancid, musty, or other objectionable odors.

Moisture content of product: Not over 4%.

Sulfur dioxide content: 400 - 600 ppm.

Packaging: 1 lb. per No. 10 can.

Defect tolerances: No extraneous matter; not more than 2% heat damaged, or stringy units, 1% unsnipped ends; and 3% spotted, blemished, or otherwise damaged units.

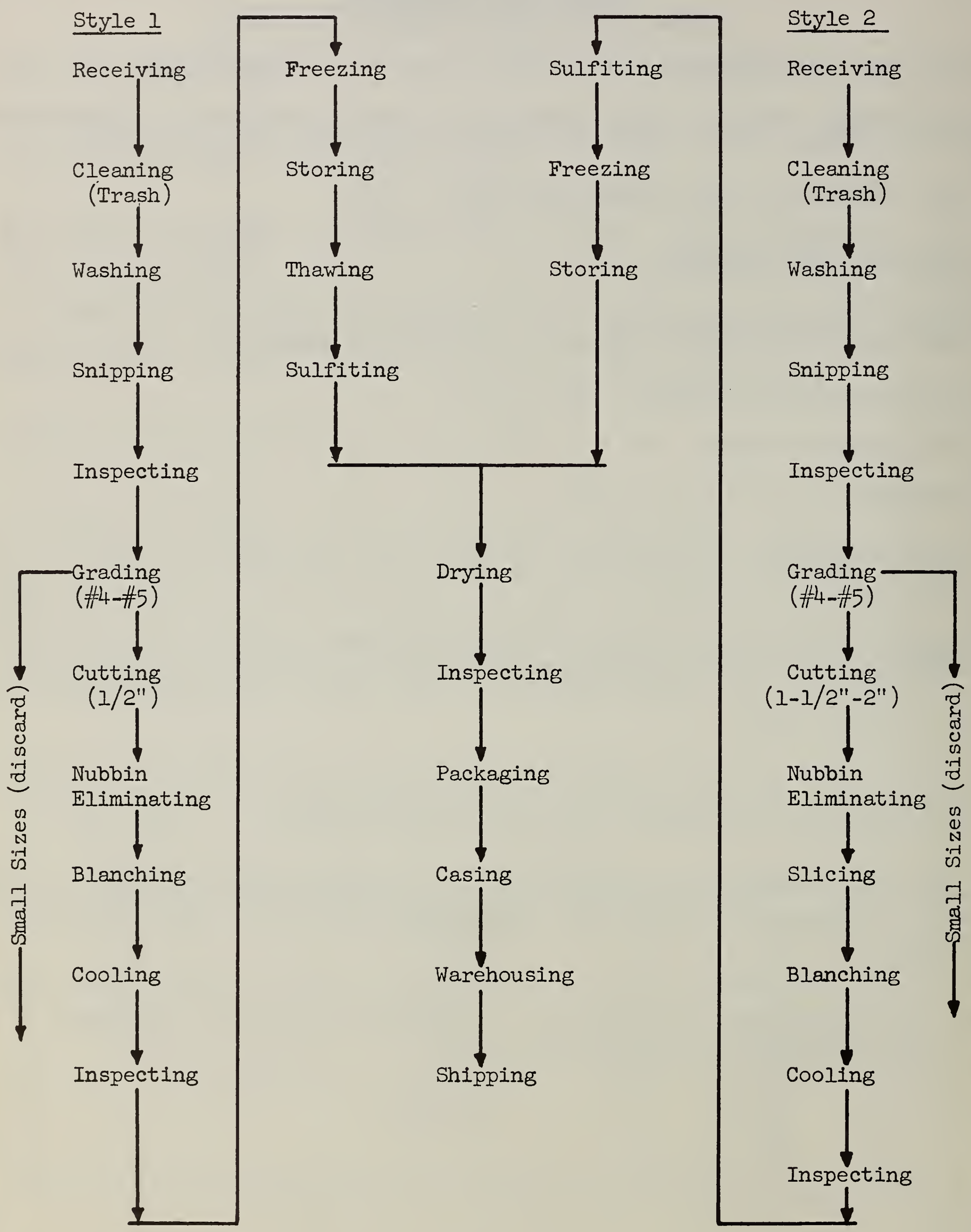
Comments: Most of the available technical information is based on experimental work done under contract with Quartermaster Food and Container Institute for the Armed Forces. 1/ Plant production of this product has been undertaken only on a limited scale.

In the Specification, two acceptable varieties are named: Blue Lake and Tendergreen. These are widely grown in the major green bean areas of the country so that acceptable raw material should be readily available.

Beans under No. 4 size are eliminated as they do not reconstitute properly after dehydration. As indicated in the flow sheet, freezing before drying is required. This is necessary to obtain proper rehydration and texture, and it also aids drying.

1/ Litwiller, E. M., and Pettit, L. A. "Dehydrated Blue Lake green beans" FOOD TECHNOLOGY 11:229-31, April, 1957.

FLOW SHEET (Beans, Green, Dehydrated)



Beets, Dehydrated
Type I, Diced; Type II, Julienne

Applicable Specification: MIL-B-3024, issued on 3 August 1949.

Raw material: U. S. No. 1, except for size, clean, sound, mature, dark red variety, free from light rings; tender texture when cooked.

Major dehydration areas during World War II: New York, New Jersey, and Oregon.

Piece size before drying: (Type I), dice, 3/8"; or half-dice 3/8"x3/8"x3/16"; (Type II), strips, 3/16" x 3/8" x 3/4" to 1-1/2" long.

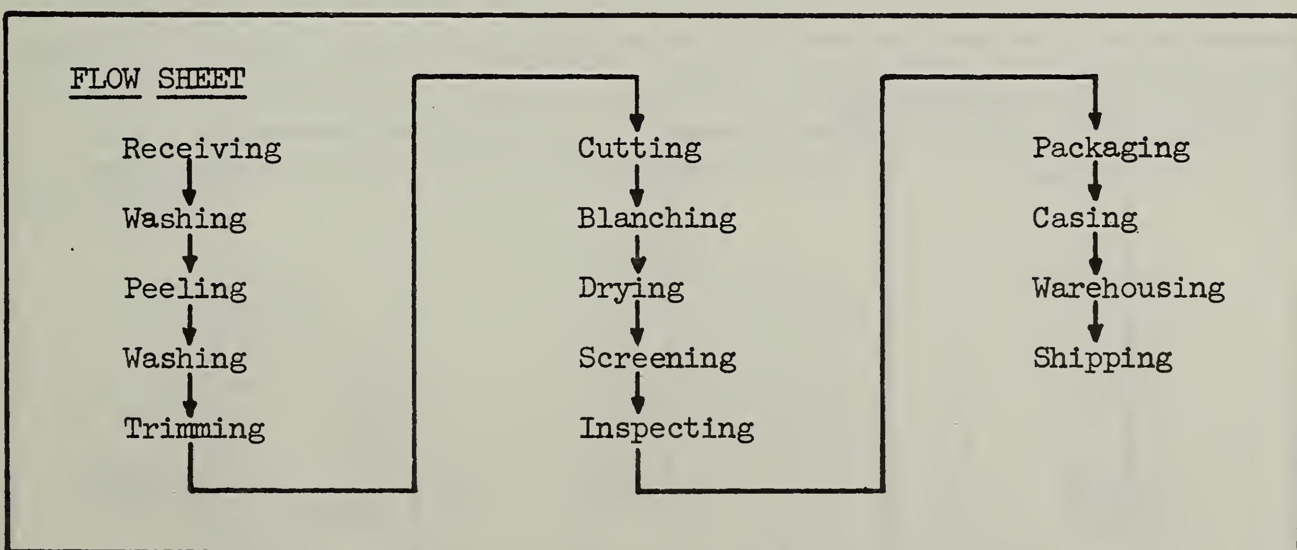
Finished product requirements: Not more than 1% through an 8 mesh screen; good, typical, reasonably uniform dark red color; good typical beet aroma, free from haylike or other objectionable odors; good beet flavor; good, tender texture free from woodiness.

Moisture content of product: Not over 5%.

Sulfur dioxide content: None.

Packaging: 2-3/4 lb. per No. 10 can **(commercial pack)**

Defect tolerances: Not more than 2% (dice or half-dice) or 4% (strips) of defective pieces damaged by insect or pathological injury, decay, scorch, bruise, tray blackening, dirt, peel, discoloration, or other abnormality.



Beets, Dehydrated
(continued)

Blanching may be done either before or after peeling and cutting. Advantages of doing blanching first include:

1) Better and smoother cutting and fewer fines generated in cutting operation. Heat makes beets more flexible so that random cracking of the tissue does not occur ahead of the cutting edges.

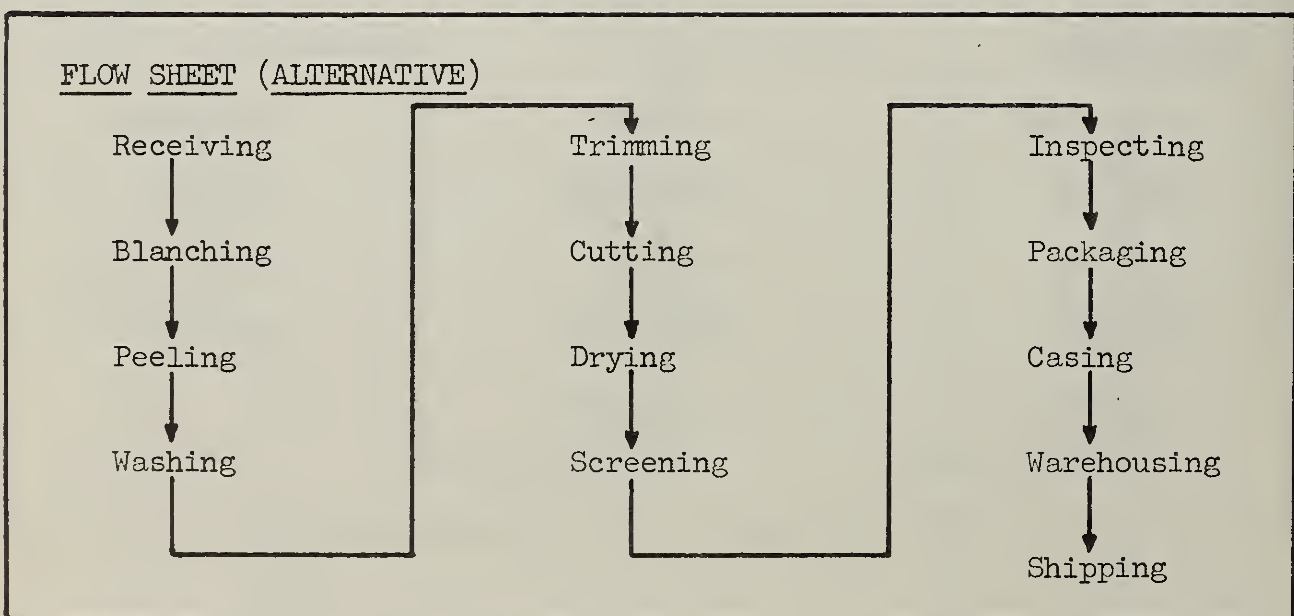
2) Product color better as the pigment is set by heat; less bleeding occurs when beets are cut.

Advantages of blanching after peeling and cutting include:

1) Blanching of small uniform size pieces more uniform than blanching whole beets of irregular sizes and shapes. In the blanching of whole beets the outside may be subjected to steam for 15 to 30 minutes before center has attained blanching temperatures.

2) Smaller size blanching equipment because of shorter blanching time for cut product.

Increasing numbers of beet canneries are blanching prior to cutting. Dehydrators of other root crops such as potatoes, carrots, and rutabagas follow the practice of cutting prior to blanching.



Cabbage, Dehydrated
Shreds

Applicable Specification: MIL-C-826, issued on 27 July 1949.

Raw material: U. S. No. 1, except for size; clean, sound, mature, good cooking quality; Danish, Domestic Pointed, Savoy, or other green varieties preferred; red varieties not permitted.

Major dehydration areas during World War II: California and New York.

Piece size before drying: Shreds not less than 1/8" or more than 1/4" in width.

Finished product requirements: Not more than 15% through an 8 mesh screen; bright, typical color; good, typical aroma, free from haylike, scorched, musty, or other objectionable odors; good, typical cabbage flavor when cooked.

Moisture content of product: Not over 4%.

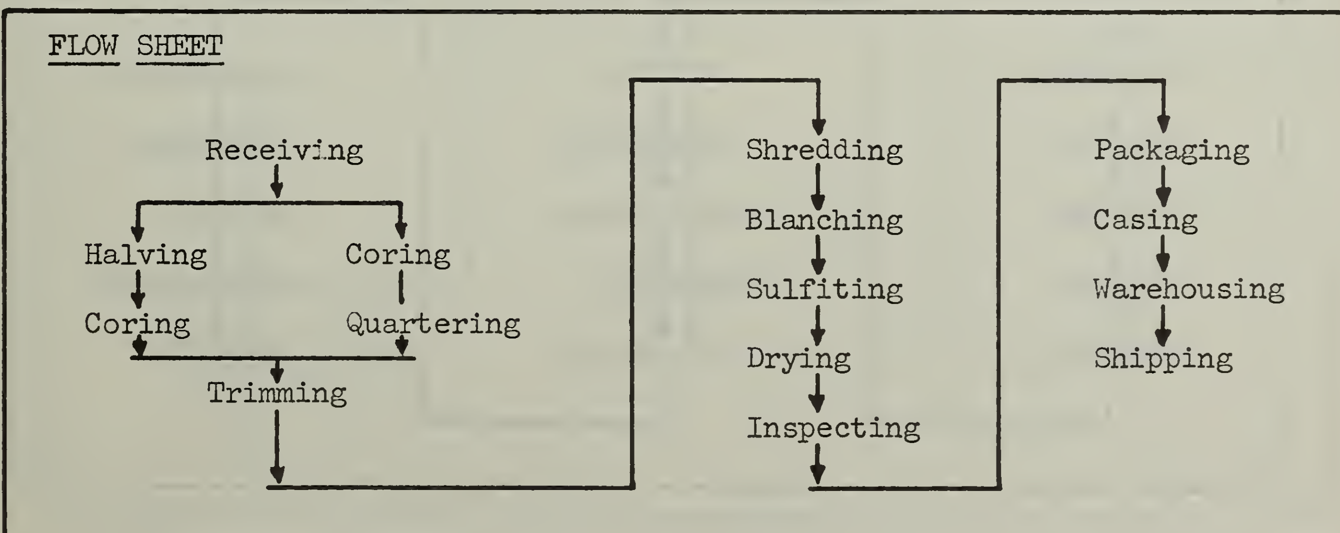
Sulfur dioxide content: 1500 to 2500 ppm.

Packaging: Gas packed; 1-3/4 lb. per No. 10 can (commercial pack).

Defect tolerances: Not more than 2% defective pieces such as caused by insect or pathological injury, decay, scorch, bruise, tray blackening, dirt, peel, tough fibrous core, and discoloration.

Comments: Tunnel drying of cabbage differs from tunnel drying of other products in that shredded cabbage is usually loaded on the drying trays prior to blanching. This obviates transfer of soft blanched material from a blanching belt to drying trays as is the practice for other commodities. Screen-bottom trays in place of conventional wood slab trays are used when the trays go through the blancher.

The handling of the product through bin drying, inspection, and packaging must be done with special care to prevent breakage, or too many fines will be caused. A screening operation may be necessary after inspection to remove excess fines.



Carrots, Dehydrated
Type I, Diced; Type II, Julienne

Applicable Specification: MIL-C-839, issued on 28 July 1949.

Raw material: U. S. No. 1, except for size; Red Cored Chantenay, Imperator, or similar varieties; clean, sound, mature, of good typical orange color, and of good cooking quality.

Major dehydration area during World War II: California

Piece size before drying: (Type I) dice, 3/8"; or half-dice, 3/8"x3/8"x3/16"; (Type II) strips, 3/16" x 3/8" x 3/4" to 1-1/2" long.

Finished product requirements: Not more than 1% through an 8 mesh screen; good, bright, typical color; good, typical aroma, free from haylike, scorched, musty, rancid, or other objectionable odors; good, typical flavor; and good tender texture free from woodiness.

Moisture content of product: Not over 4%.

Sulfur dioxide content: 500 to 1000 ppm.

Packaging: 2-3/4 lb. per No. 10 can; inert gas pack.

Defect tolerances: Not more than 2% (dice or half-dice) or 4% (strips) of defective pieces damaged by insect or pathological injury, decay, scorch, bruise, tray blackening, dirt, peel, pithy core, discoloration, or other abnormality.

FLOW SHEET

Receiving → Washing → Peeling → Washing → Trimming → Cutting → Blanching → Sulfiting → Drying → Screening → Inspecting → Packaging → Casing → Warehousing → Shipping

Cranberries, Dehydrated
Type I, Powdered

Applicable Specification: MIL-C-827A, issued 4 September 1951.

Raw material: Characteristic red color; clean, dry, sound, well developed and mature; free from brown, soft, or rotten berries.

Major dehydration areas during World War II: Massachusetts.

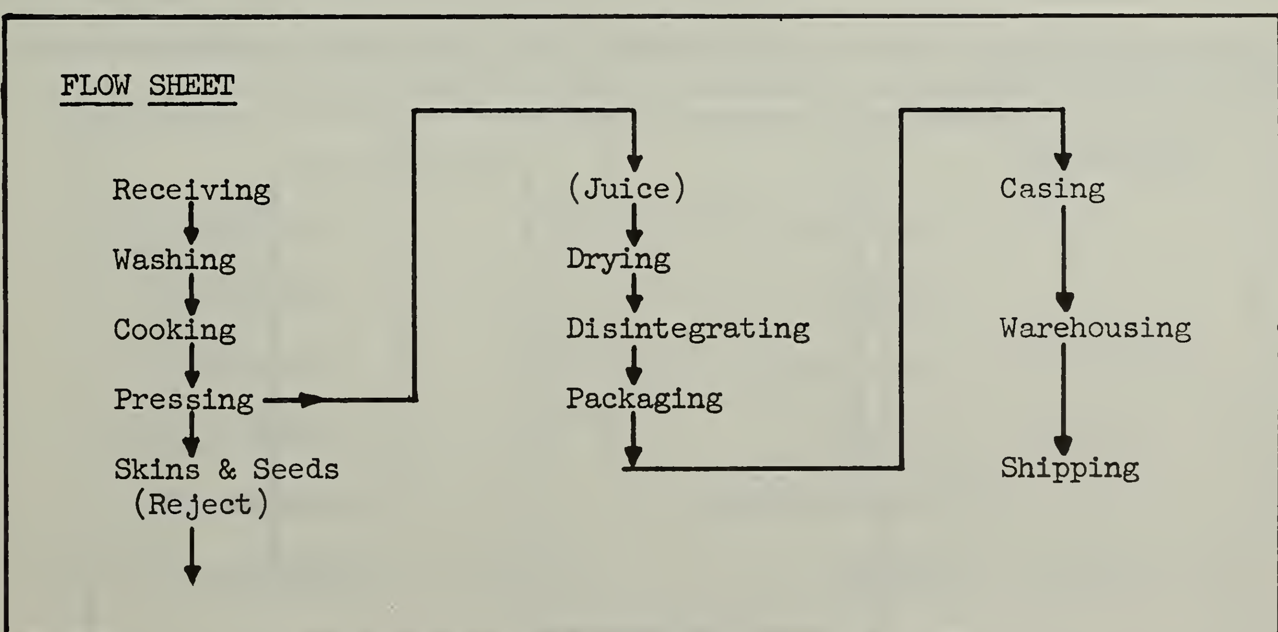
Finished product requirements: 100% through a 20 mesh screen; free-flowing powder, bright color; slightly firm consistency, distinct cranberry flavor, free from carmelized or haylike taste when prepared as jelly.

Moisture content of product: Not over 5%.

Sulfur dioxide content: None

Packaging: 1 lb. per No. 2-1/2 can or in suitable wax-dipped carton.

Defect tolerances: Free of skins, seeds, grit, fillers, preservatives, artificial coloring, or other foreign material.



Cranberries, Dehydrated
Type II, Sliced; Type III, Whole

Applicable Specification: MIL-C-827A, issued 4 September 1951.

Raw material: Characteristic red color; clean, dry, sound, well developed and mature; free from brown, soft, or rotten berries.

Major dehydration areas during World War II: Massachusetts and Washington.

Piece size before drying: (Type II,) slices; (Type III,) whole berries.

Finished product requirements: Bright color, slightly darker than raw characteristics; when cooked as a sauce, semi-solid, uniform dark red color, sweet and tart, free from haylike or scorched flavor.

Moisture content of product: Not over 5%.

Sulfur dioxide content: None.

Packaging: (Type II,) 1 lb. (compressed) per No. 2-1/2 can; (Type III,) 1 lb. (compressed) in suitable wax-dipped cartons.

Defect tolerances: Product and packages free from insect infestation, rot, mold, preservative, artificial coloring, or other foreign material.

FLOW SHEET

Receiving
↓
Washing
↓
Inspecting
↓
Slicing
(or perforating
for whole berries)
↓
Drying
↓
Bin Drying
↓
Inspecting
↓
Packaging
↓
Casing
↓
Warehousing
↓
Shipping

Juice, Grapefruit, Dehydrated
Juice, Orange, Dehydrated
Powder

Applicable Purchase Descriptions: For Juice, Grapefruit, Dehydrated, issued 2 April 1956, and for Juice, Orange, Dehydrated, issued 3 April 1956.

Raw material: Grapefruit juice concentrate -- not less than 50° Brix, Brix-acid ratio between 8.5 to 1 and 14 to 1; made from fruit having a Brix-acid ratio between 7.5 to 1 and 14 to 1, pulp content between 4 and 12%, and oil content not over .005% when reconstituted to 11° Brix. Orange juice concentrate -- not less than 55° Brix, Brix-acid ratio between 11.5 to 1 and 16 to 1, made from fruit having a Brix-acid ratio between 10.5 to 1 and 18 to 1, pulp content between 4 and 12%, and oil content not over .005% when reconstituted to 12° Brix. Grapefruit and orange oils shall be U. S. Pharmacopoeia cold-pressed oils of single strength or partially deterpenized oils prepared therefrom.

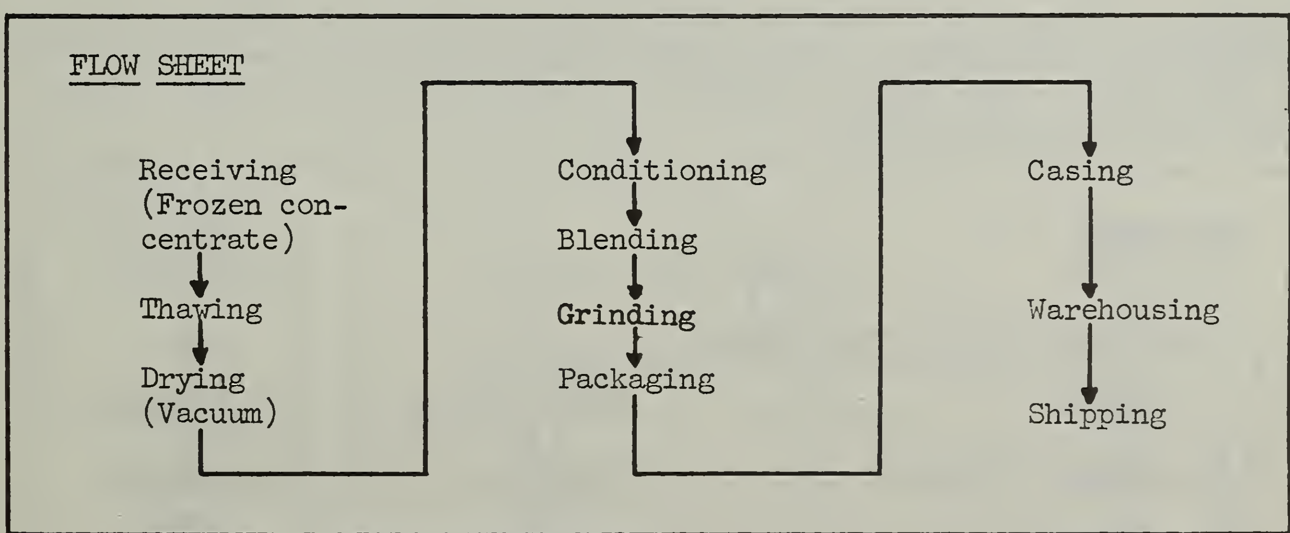
Major dehydration area during World War II: None.

Finished product requirements: 100% through a 10 mesh screen; readily wettable when reconstituted at 70°F. Oil content when reconstituted -- .006% to .012%. Free from bitter, oxidized, scorched, terpene-like, and other off-flavors; flavor equivalent to standard reference sample.

Moisture content of product: Not over 2.5%.

Sulfur dioxide content: 100 to 250 ppm.

Packaging: Grapefruit juice powder, 15 ozs. per qt. can; orange juice powder, 16 ozs. per qt. can; with in-package desiccant.



Onions, Dehydrated
Type I, Flaked; Type III, Sliced

Applicable Specification: JJJ-0-533, issued on 8 August 1956.

Raw material: White or yellow varieties having prominent pungent characteristics, solids at least 8%, free from damage caused by dirt or other foreign matter, splits, seedstems, moisture, sunburn, etc.

Major dehydration areas during World War II: California and Idaho.

Piece size before drying: Slices not more than 1/4" thick.

Finished product requirements: (Type I), not more than 3% through a 16 mesh screen. (Type III), not more than 3% through a 16 mesh screen nor more than 55% through a 3 mesh screen. Bright uniform dehydrated onion color; typical aroma, free from haylike or other objectionable odors; good typical onion flavor with prominent pungency, not bitter or mild.

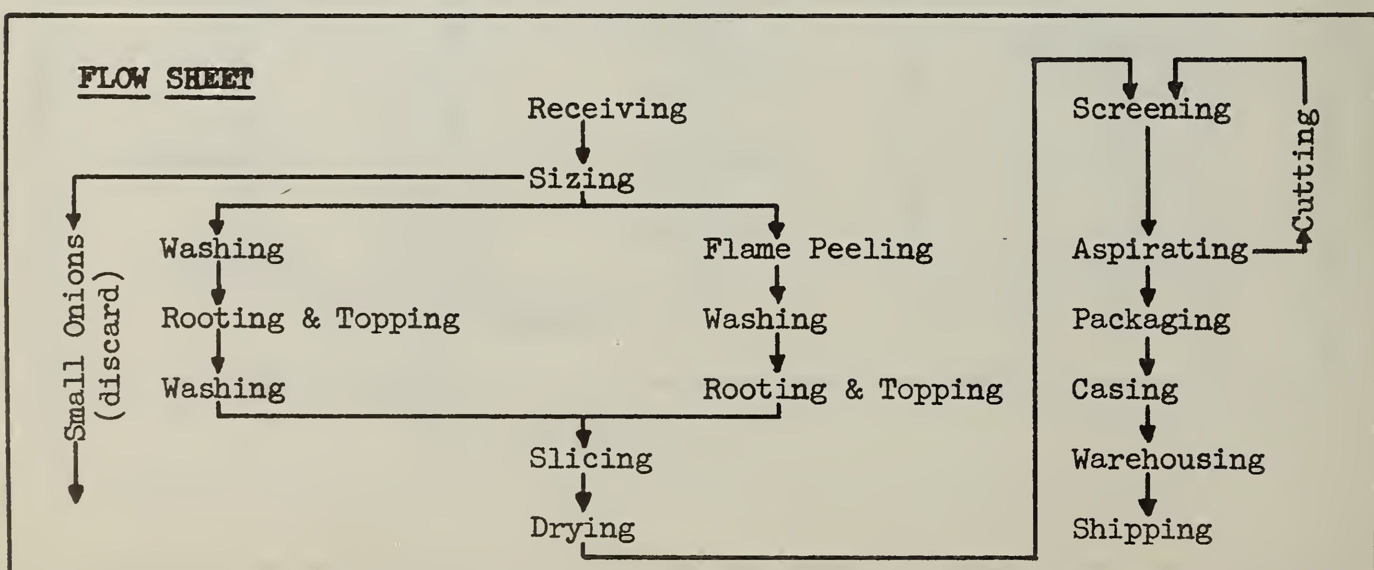
Moisture content of product: Not over 4%.

Sulfur dioxide content: None.

Packaging: (Type I) 2-1/2 lb. per No. 10 can; (Type III) 1-3/4 lb. per No. 10 can.

Defect tolerances: Not over 2% by weight defective pieces of which not more than 1/4 shall be root bases, tops, or skins. Defects also include scorch, tray blackening, dirt, discoloration, decay, disease, insect, mechanical, or other damage.

Comments: In commercial practice, highly pungent and high solids onions are used entirely if available. The Southport White Globe has been very satisfactory for many years. Some special strains have been developed in recent years specifically for dehydration.



Peas, Green, Sweet, Dehydrated

Applicable Purchase Description: Issued in 1955.

Raw material: Varieties and sizes -- Dark Seeded Perfection, #3 and #4. Thomas Laxton, #3, #4, and #5. Characteristics -- tenderometer reading 90-100; freshly vined or frozen.

Major dehydration areas during World War II: None.

Finished product requirements: Good uniform green color; free from scorched or discolored seeds and haylike, scorched, rancid, musty, or other objectionable odors.

Moisture content of product: Not over 4%.

Sulfur dioxide content: 300 to 500 ppm.

Packaging: 3 lb. per No. 10 can (experimental data).

Defect tolerances: No harmful extraneous vegetable material; not more than 2% heat damaged units; 3% spotted, blemished, or otherwise damaged units, including not more than 1% damaged by pathological or insect injury.

Comments: Most of the available technical information is based on experimental work done under contract with Quartermaster Food & Container Institute for the Armed Forces. Production has not been beyond the pilot plant stage necessary for trial procurement for test purposes.

A step not found in processes for other dehydrated products is necessary for green peas, namely, that of slitting the skins. The specifications require that not less than 98% of the peas be split with a 1/8" long cut. Without slitting, the dehydration and rehydration times are excessive. Size grading prior to slitting is necessary to attain this requirement with the available commercial equipment. Small sizes are eliminated, as storage studies indicate they are more subject to browning because of their higher sugar and amino acid content.

FLOW SHEET

Receiving → Vining → Washing → Grading (Size) → Blanching → Grading (Quality) → Freezing → Storing → Thawing → Slitting → Sulfiting → Drying → Inspecting → Packaging → Casing → Warehousing → Shipping

Potatoes, Sweet, Dehydrated
Type I, Sliced; Type II, Diced; Type III, Julienne

Applicable Specification: MIL-P-3025, issued on 3 August 1949, and amendment 1, issued on 30 November 1949.

Raw material: U. S. No. 1 or 2; moist type; clean, sound, mature, deep yellow or pink; good cooking quality; no discoloration or sogginess after cooking.

Major dehydration area during World War II: Louisiana.

Piece size before drying: (Type I,) slices, 1/8" to 1/4" thick; (Type II,) dice, 3/8"; half-dice, 3/8" x 3/8" x 3/16"; (Type III,) strips, 3/8" x 3/16" x 3/4" to 1-1/2" long.

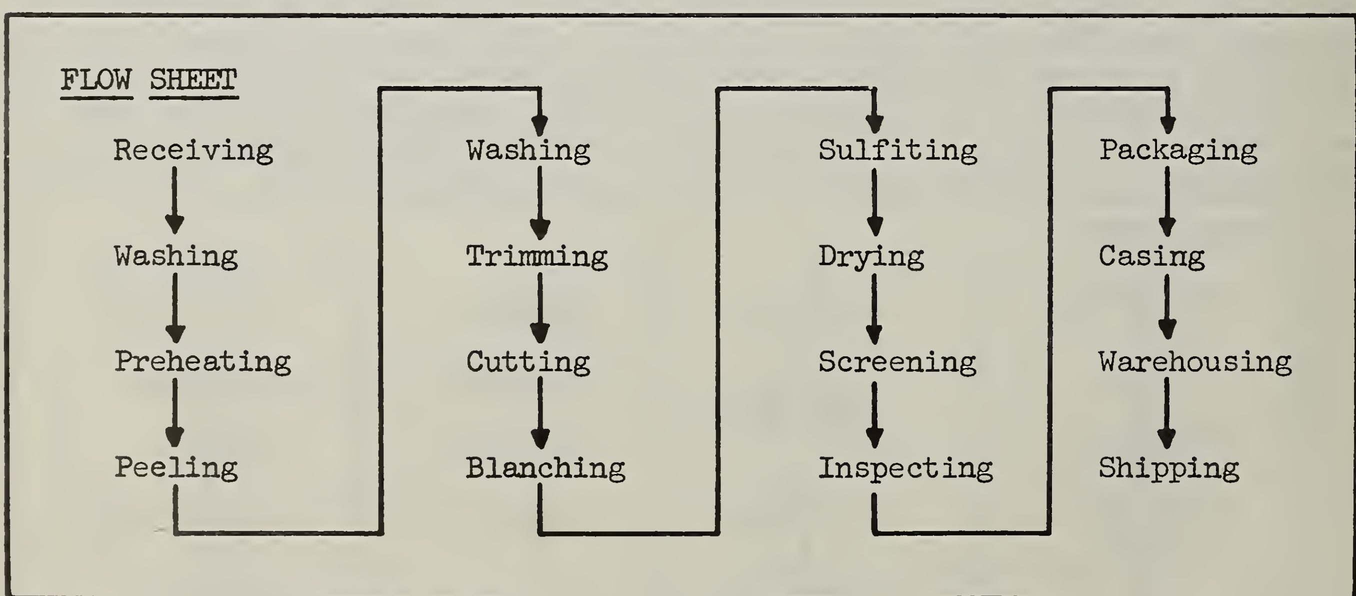
Finished product requirements: Bright, uniform, typical color; good typical aroma, free from haylike, scorched, musty, rancid, or other objectionable odors; good, typical flavor free from sourness or bitterness; soft and tender but not soggy or gummy after cooking.

Moisture content of product: Not over 5%.

Sulfur dioxide content: 200 to 500 ppm.

Packaging: Slices, 2 lb. per No. 10 can; dice and strips, 3 lb. per No. 10 can.

Defect tolerances: Not more than 6% (slices), 2% (dice) and 4% (strips) of defective pieces damaged by peel, tray blackening, insect injury, decay, imbedded dirt, heavy fiber, or discoloration.



Potatoes, White, Dehydrated
Type I, Diced; Type II, Julienne

Applicable Specification: MIL-P-1073A, issued on 12 December 1950, with Procurement Exceptions.

Raw material: Sound, mature potatoes of similar drying characteristics, and of mealy texture when cooked. No "sunburns" to be used, nor potatoes which discolor or become soggy after boiling. Russet Burbank, Rural Russet, Green Mountain, Triumph, Katahdin, or similar varieties suggested.

Major dehydration areas during World War II: Idaho, Washington, Maine, and California.

Piece size before drying: (Type I,) half-dice, 3/8" x 3/8" x 3/16"; (Type II,) strips, 3/8" x 3/16" x 3/4" to 1-1/2" long.

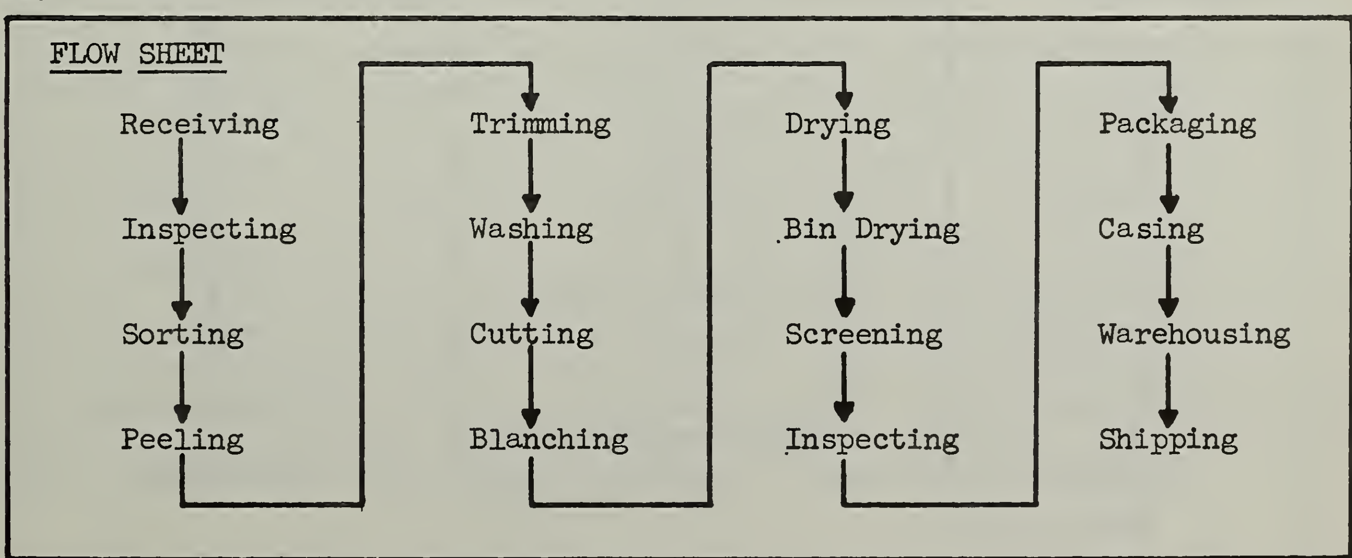
Finished product requirements: Not more than 1% through an 8 mesh screen for half-dice. Bright, uniform white potato color ranging from light cream to pale yellow depending on variety, and free from haylike, scorched, rancid, musty, or other objectionable odors; mealy, typical white potato texture when cooked.

Moisture content of product: Not over 6%.

Sulfur dioxide content: 200 to 500 ppm.

Packaging: (Types I and II,) greatest practicable fixed quantity per No. 10 can; or (Type I) 14 pounds to 18 pounds and (Type II) 14 pounds to 16 pounds per 5 gallon can.

Defect tolerances: Not more than 3% (half-dice) or 6% (strips) of defective pieces damaged by pathological injury, peel, eye, bruise, tray blackening, scorching, or other discoloration.



Potatoes, White, Dehydrated
Type IV, Class 1, Granules

Applicable Specification: MIL-P-1073A, issued on 12 December 1950.

Raw material: Sound, mature potatoes of similar drying characteristics, and of mealy texture when cooked. No "sunburns" to be used, nor potatoes which discolor or become soggy after boiling. Russet Burbank, Rural Russet, Green Mountain, Triumph, Katahdin, or similar varieties suggested. Currently Idaho Russet Burbanks are being used almost exclusively.

Major dehydration areas during World War II: None.

Piece size before drying: (Type IV, Class 1,) **granular form.**

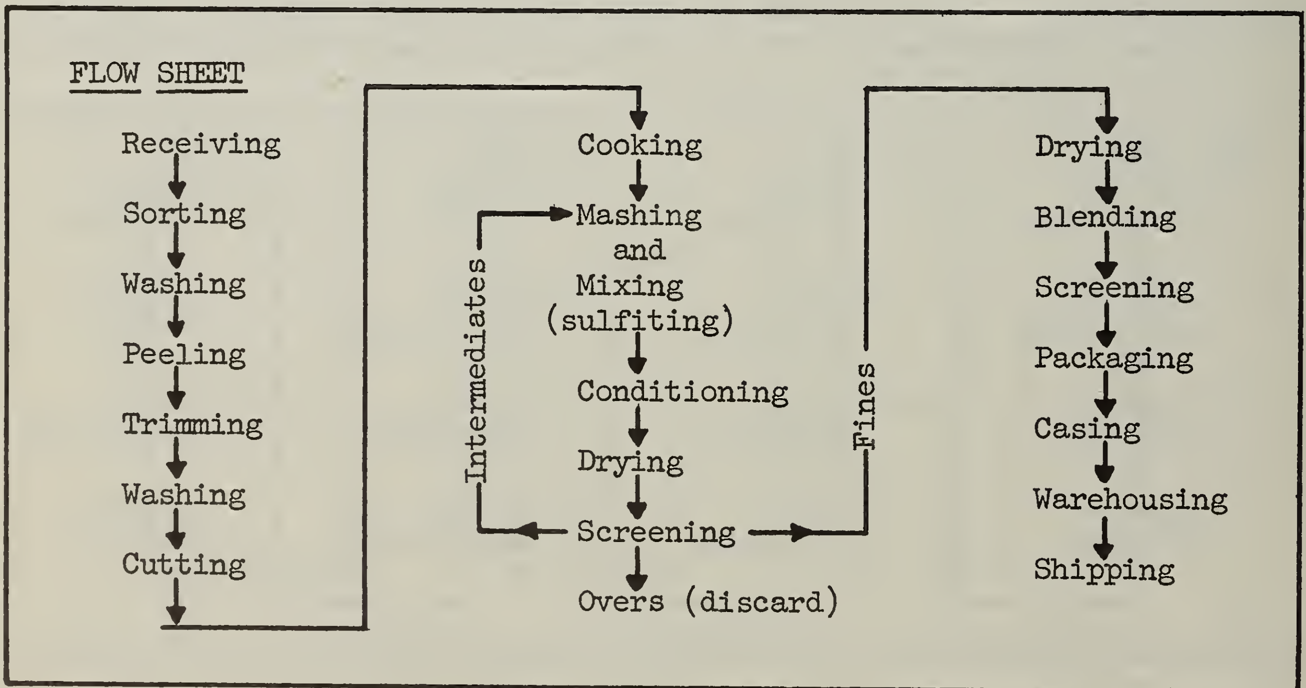
Finished product requirements: 100% through a 40 mesh screen; bright uniform white potato color ranging from cream to light ivory depending on variety, and free from haylike, scorched, rancid, musty, or other objectionable odors. Typical fluffy mashed potato texture, free from gumminess, pastiness, and lumps when cooked.

Moisture content of product: Not over 6%.

Sulfur dioxide content: 200 to 400 ppm.

Packaging: 6-1/8 lb. per No. 10 can; inert gas pack.

Defect tolerances: Free from noticeable particles of skin and foreign material.



CHAPTER IX

PRE-DRYING OPERATIONS AND EQUIPMENT

The general discussions of procedures and facilities in the following three chapters are applicable to most of the commodities considered in Chapter VIII.

The Importance of Proper Preliminary Planning

The successful operation of a dehydration plant largely depends upon the care with which the plant was planned prior to its location and construction. Even though the initial cost of the plant and equipment may appear high, it is only a minor consideration in determining the processing cost per pound of product. Costs of raw material, labor, packaging supplies, etc. are far greater than the capital charges. Construction of the plant must, however, be given careful consideration. Building design, kind of equipment, process installed, and plant layout are governing factors in the efficient operation of a dehydration plant. The plant must be engineered to make efficient use of labor, equipment, floor space, supplies, and utilities, to process raw materials without damage and waste, and to maintain satisfactory production schedules.

A properly planned dehydration plant is not designed rigidly around a particular piece of equipment or around a certain step in the process. The various operations must be balanced -- without "bottlenecks". The capacity of each piece of equipment should be such that a proper operating balance can always be maintained even though raw material quality may be extremely variable.

To insure continuous operation and to provide reserve capacity, it may be desirable to install duplicate or reserve equipment for certain critical processing steps. Some equipment in the larger plants will normally be multiple-unit, for example, tunnels and dicers will be installed in multiples, and failure of one will not close down the plant. Due consideration should be given also to applying this principle when installing, or providing as "spares", peelers, washers, trim tables, blanchers, boilers, and packaging equipment to avoid complete shut-downs in case of failure of any one critical piece of equipment. Furthermore, an inventory of vital replacement parts must be on hand or readily available. During an emergency period, production is paramount. Every possible effort should be made to avoid all shut-downs due to equipment failure. Plants will operate continuously as long as the raw material is available. Because of the continuous operation and long processing seasons likely, plant and equipment must be of rugged construction.

Procedures and Equipment

A. General Considerations

Differences in operating procedures, as between plants, result mainly from differing methods of applying the basic dehydration processing steps. Information presented in this Handbook pertains to equipment and operating procedures which have been proved in commercial practice and which can be effectively utilized in an emergency expansion of the vegetable and fruit dehydration industry.

General considerations for individual decisions in choosing methods for performing various processing steps are discussed in the following sections. Some basic principles pertinent to influencing these decisions are:

1) Any essential procedure considered must be clearly beyond the experimental stage of development. An emergency period is no time for experimentation with a machine or a processing step, unless it does not hinder production. Only procedures and machines of proved or unquestionable performance should be considered. Consequently, prospective dehydrators must rely heavily on present dehydration practices and on commercially available items of equipment.

2) The processing steps chosen must be efficient, trouble-free, and not damaging to or wasteful of the raw commodity. It has been pointed out before that the initial cost of plant and equipment is not nearly as important in determining production costs as is the effectiveness of the process chosen. Thus, if two procedures are available, one of which involves a sizable investment but has been proved to be efficient and foolproof, and the other of which involves a modest investment but is of doubtful efficiency and surety of operation, there should be little question that the former is to be preferred.

3) Processing methods which require a reasonable minimum of labor should be installed. There is always the question whether a plant should be highly mechanized or more dependent on labor. In a plant for an emergency period anticipated to be of short duration, there are important reasons to favor emphasis on hand labor. Experience in World War II, however, was such that in some areas plants had great difficulty in properly staffing each operating shift. Competition from other industries, general shortage of help, and an independent attitude on the part of many employees were contributing factors. Selection of the processing method, therefore, may be very important in assuring continued and maximum production in the plant in a critical labor area.

4) Highly complex machinery and processes should be avoided unless the required machinery is readily available and has been thoroughly proved in commercial operation; furthermore, such machinery also requires highly skilled repair men and operators. Not only is the complexity of the machine involved, but also the ability of the plant to develop successful operating procedures quickly. The seemingly more costly manual method may prove actually to be the least costly if it insures immediate and successful application.

5) The availability of information or advice on a procedure is important. A procedure may of necessity be avoided if its use must remain the secret knowledge of one company or person. Equipment manufacturers are usually very helpful in aiding customers in choosing proper equipment and in seeing that the equipment works successfully. Prospective operators must avail themselves of these and other sources of consulting services and advice, which will materially aid in the choice of desirable operating procedures.

B. Specific Procedures and Equipment

The following is a discussion of each operating step and is coded in conformance with Appendix H.

100. RAW COMMODITY PROCUREMENT

130. Field Grading

Raw commodity may be brought into the plant as field-run or as pregraded material. If the raw commodity is purchased from commercial sources such as packing or shipping houses, it may have been graded.

For raw material purchased directly from the growers, a preliminary grading operation may be performed in the field. If a large proportion of the crop is of undesirable small sizes, it would be advantageous to remove these in the field and save cost of shipping to and handling at the plant. The field sizer would also remove dirt, rocks, etc.

150. Transportation and Weighing

The custom of the area may establish whether the plant or the grower is responsible for hauling. The loads may be weighted on public scales, if available, or at the plant.

160. Storage

Storage of raw materials is required for the following purposes:

1) To insure a continuous supply of raw material to the processing line

2) To extend length of processing season

3) To condition certain commodities such as potatoes and onions

The raw material required to assure a continuous supply to the processing line should be held at or near the processing site. The amount needed for this purpose may range up to a 10-day supply or even more depending on the season of the year, plant location, and harvesting methods required for the raw material. Crops that deteriorate rapidly after harvest cannot always be held long enough to assure continuous operation. Often failure of crops to reach maturity at scheduled times, poor harvesting weather, or shortages of field labor may cause the plant to shut down.

With the exception of cabbage, carrots, and beets, the commodities considered in this Handbook are usually stored to extend the processing season. Beets may sometimes be stored if conditions warrant. When raw material is stored for long periods, space required for storage may be greater than that for the rest of the plant. This storage space has commonly been located at other than the processing site.

Potatoes in storage may be held at higher than normal storage temperature to reduce sugar content so that better dried products may be produced. Onions in storage may be subjected to drying conditions to reduce moisture in skins for easier peeling.

Storage conditions required depend on the individual raw material. Plants processing citrus juice powders, green peas, and green beans require freezer space to hold their raw materials. Cranberries use refrigerated storage for extended holding. Potatoes are held in cellars at 35° - 40°F. for extended holding and are warmed to 65° - 70°F. for one to three weeks prior to processing. Sweetpotatoes are best held at 55° - 60°F. with relative humidity at 75% to 85%. Onions are usually held in common storage until processed.

170. Containers

The raw commodity may be hauled in pallet boxes, lugs, crates, baskets, or sacks, or it may be hauled in bulk in large trucks and/or trailers. Bulk hauling is often used when the material is not subject to mechanical damage. Cabbage is commonly hauled in bulk, as are potatoes in some areas. It is usually customary for the dehydration plant to furnish the containers. Generally, in planning operation, provision must be made for sufficient containers to handle the fresh commodities processed during the harvest period plus the commodities which must be stored for later processing.

Processed commodities, such as frozen peas, green beans, and citrus concentrates require other types of containers. For the first two items a wide range of containers may be used. Pallet boxes with fiberboard sides, fiberboard boxes with and without liners, and multiwall paper bags with liners have been used for holding these products for reprocessing. Citrus concentrates are commonly held in steel drums with polyethylene liners.

200. MANUFACTURING OPERATIONS

210. Raw Material Handling in Plant

A. Weighing

A scale to weigh large truck-trailer combinations is advisable. The ready availability of public scales, however, may eliminate need for one at the plant.

Considerable quantities of dirt sometimes remain in the incoming raw commodity. Some provisions must be made for determining the weight of this dirt and adjusting the price paid for the commodity.

BULK HANDLING OF RAW CABBAGE

(Courtesy of Western Canner & Packer and Cal-Compack Foods, Inc.)

PALLETIZED HANDLING OF SACKED RAW COMMODITY

(Courtesy of Basic Vegetable Products, Inc.)

B. Unloading and storing at plant

Lift-truck operation is suggested for all commodities not received in bulk. The plant floors, therefore, may be ground level. In order to make use of the lift-truck for unloading, the raw commodity may be loaded on pallets or on trucks at the field. The raw commodity is then held on the pallets during hauling, unloading, and plant storing until it is placed at the starting point of the preparation line. Lift-trucks with clamp jaws may be used to handle boxes or barrels when pallets are not used. Studies have shown that use of lift-trucks can cut in half the time and labor needed to load or unload a highway truck or railroad car. A further saving in time and labor results from the rapid and efficient handling of the bigger loads within the plant.

Provision should be made for the blending of two or more lots of raw commodity when necessary to maintain efficient plant operation. This frequently arises when one lot of raw commodity is exceptionally free of defects and another is below standard in this respect. If used exclusively, the former may require only half the trimmers normally used, and the latter would require more trimmers than would be normally available to maintain plant output. A proper blend of the two lots would allow a reasonable plant operation rate and efficient utilization of all labor.

C. Feeding to line

Provision for supplying a steady and continuous flow of raw commodity to the processing line is necessary. Flow-control is necessary, and the head of the processing line is usually the major control point.

The method of handling raw commodity from storage to the processing line may be selected from several common practices. The use of fluming for some root vegetables is highly successful; fluming decreases bruising and serves as a prewashing step. For other commodities which are initially handled dry, conveyors or lift-trucks are more satisfactory.

Many types of conveyors, elevators, etc., are used. Portable conveyors are convenient means of transferring commodity from a large part of the receiving area. Washer-elevators, in addition to conveying, provide a preliminary washing or soaking of the commodity. Conveyors also serve as a convenient preliminary sorting or grading point. Feed hoppers may provide soaking or washing preliminary to feeding to line.

D. Sizing and sorting

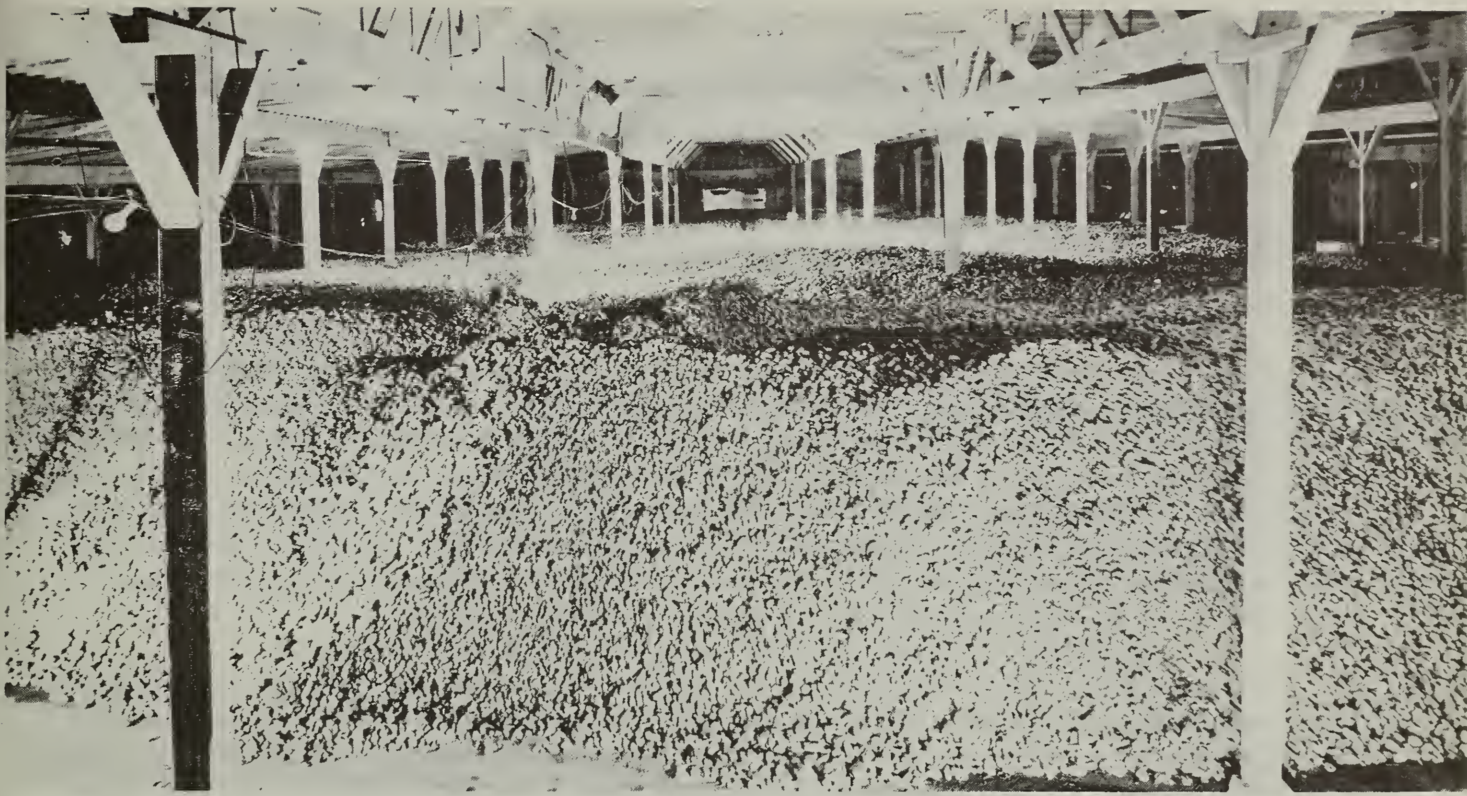
Sizing operations may be necessary in some plants to remove sizes and shapes undesirable for processing and to divide the raw material into sized lots for more efficient processing.

E. Handling and loading containers

Storage space will be required for holding empty sacks and boxes from one season to the next. If the boxes are durable and sturdy, they may

BULK STORAGE OF POTATOES IN CELLAR

(Courtesy of Western Canner & Packer)



EMPTYING SACKS OF FRESH ONIONS INTO HOPPER FEEDING PREPARATION LINE

(Courtesy of Basic Vegetable Products, Inc.)

be stacked (bottom side up) in piles outdoors. Sacks and lightweight boxes may be stored indoors in raw commodity storage areas. Sacks must be kept dry to prolong their life.

220-230. Preparing for Drying

A. Washing

Root-type vegetables, excepting onions, should always be washed before peeling to remove dirt or other foreign material. A clean surface is an aid to good peeling operations, especially when either steam or lye peeling is used. Removal of abrasive material also protects such equipment as continuous steam peelers and cutting knives. Lye consumption is increased by the presence of foreign material. If dirt adheres to onions at harvest, much of it will be lost by removal of paper skins and by tumbling during the first processing steps.

If vegetables must be dug in wet fields an extra amount of dirt may be expected. To remove large quantities of dirt and debris from the raw material, a "dry washer" preceding a standard water washer offers advantages. A "dry washer" usually consists of a horizontal rotating drum with bars, slats, or coarse screen in the outer shell. The commodity is tumbled continuously while passing through, and the bulk of adhering dirt is shaken loose and falls out through the drum openings. The commodity then passes on to convential water washers. This procedure is advantageous in that: (1) less water is required than when all the cleaning is done with water, (2) a large amount of foreign matter may be removed and disposed of without danger of blocking the water washer or the sewer line, and (3) excessive dirt in the raw commodity shipment may be removed and weighed so that price adjustments may be made (if agreed upon in the purchase contract).

B. Preheating

Vegetables which are to be peeled by lye or steam may be preheated in some instances. The preheating treatment varies for different commodities. For example, sweetpotatoes are heated at 135° to 160°F. for up to 30 minutes; white potatoes are heated at 140° to 160°F. for four to seven minutes. A preheating operation is intended to serve one or both of two purposes:

1) Conditioning before processing

It has been shown by test that preheating of vegetables such as potatoes or sweetpotatoes improves the efficiency of the peeling process and the quantity and quality of finished product. Discoloration after peeling and during drying is reduced, thus minimizing trimming and inspection labor and product losses.

2) Reducing and controlling heat load on peeler

The peeling operation is easier to control and does a more uniform job when the material has been preheated. Also, the capacity of the peeling device is increased by operating on preheated feed material.

Two types of preheaters are in use. One is a rotary machine; and the other, a long tank through which the vegetables are moved slowly by means of either a screw or a draper belt.

C. Peeling

The following general discussion applies mainly to root-type vegetables:

Lye peeling

Lye peeling was widely used during World War II, and is effective and positive on a wide range of raw commodities when properly controlled. Lye may be purchased in either solid form or in solutions of various concentrations. Although the concentrated solutions may require heating during storage in cold climates, some processors favor this to the hazards involved in dissolving the solid caustic at the plant.

The main objections to lye-peeling methods include:

1) Penetration is deeper and hence peeling losses are higher

2) Corrosiveness and health hazards of lye must be considered

3) Disposal of spent lye may be bothersome

4) Trimmings from lye-peeled vegetables are not suitable for stock-feed unless given considerable washing

5) Thorough washing of product is necessary to remove last traces of lye

6) Lye storage and make-up facilities must be provided

7) During an emergency, shortage of lye, steel drums, tank cars, etc., may limit operations

8) Laboratory control is necessary with lye-peeling

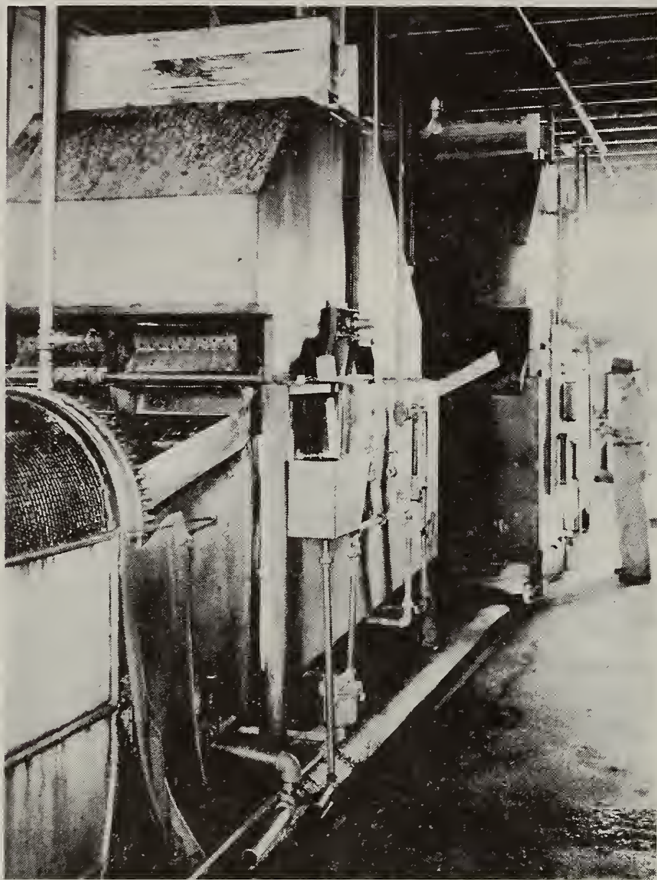
Notwithstanding these objections, lye-peeling is still being used. Operators experienced in its use have less difficulty in adapting this method to commodities which may vary in peeling characteristics, and because of the smooth, clean appearance of the lye-peeled product.

Equipment of the draper-belt type is commercially available for lye peeling. Rotary types of lye peelers are not as yet standard commercially-produced items, but several custom-built models are being used successfully.

Steam peeling

Steam peeling can be done batchwise, in retorts, or continuously in relatively new types of machines, at steam pressures up to 125 pounds per square inch. The continuous operation is desirable but involves considerably more investment.

ROTARY PREHEATER AND LYE PEELER IN PROCESSING LINE



STEAM PEELERS AND WASHERS

(Courtesy of Idaho Potato Growers, Inc.)

Steam peeling has advantages in its simplicity of operation. Some users report poor results in steam peeling withered vegetables when the maximum steam pressures are 75 pounds per square inch or less. Other operators and one manufacturer of continuous type peelers report no peeling troubles with pressures from 100 to 125 pounds per square inch.

Abrasive peeling

This method is used successfully for small batches in hotels and restaurants. It is wasteful of the product and not adapted to irregularly shaped vegetables or vegetables of various sizes. Irregularly shaped vegetables may be overpeeled on convex surfaces and remain unpeeled on all concave surfaces. After steam peeling, mild abrasion peeling may be used to remove bits of skins adhering to fibrous products such as beets.

Flame peeling

Flame peeling has been used successfully on onions. When they are subjected to temperatures in the range of 1000°F. for a short period of time, the outer surfaces (peel) will first be dried and then burned to a char. The onions are conveyed through an oven fired by either gas or liquid fuel. Flame peeling is limited in its field of application. Fuel and maintenance costs are likely to be high. Operators who have used flame peelers successfully have usually gone through a long and costly period of experimentation and research.

Manual peeling

Manual peeling is time and labor consuming and is therefore costly. It could be justified only if other suitable methods were not available, if the raw material were of such condition that other methods would not work, or if the plant were so small that machine peelers were unjustified.

Washing (to remove peel)

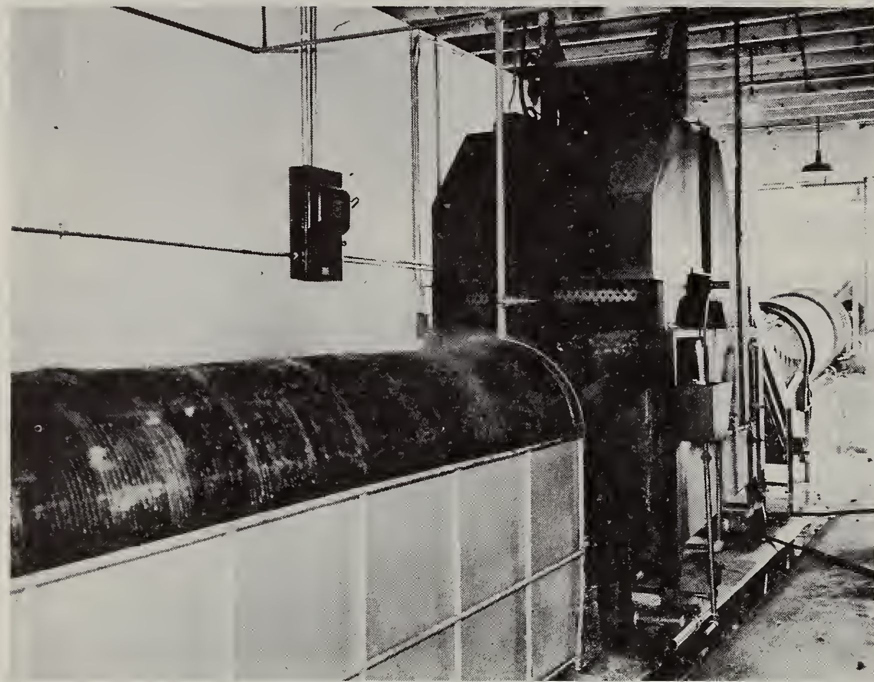
Vegetables which have been peeled with steam, lye, or flame, are subjected to a washing action under high pressure sprays which remove loosened pieces of skin and any foreign material.

D. Trimming, coring, rooting, topping, and inspecting

It is usually necessary in preparing most vegetables and fruits to remove the unwanted portions such as pieces of peel that remain, cores, crowns, tops, roots, decay blemishes, or otherwise undesirable portions. Usually this trimming operation is done by hand but in some cases it can be partially done mechanically.

Inspection of the raw commodity is necessary to insure that it is of desired quality and condition for further processing. Some operators depend on the trimmers to perform this function; and some operators put

HIGH PRESSURE WASHING AFTER LYE PEELING



PREPARING CABBAGE FOR DEHYDRATION
(Courtesy of Western Canner & Packer)

additional people for this job along the belts used to convey the product from the trimming to cutting. Roller conveyors are sometimes provided to aid this inspection operation.

In order to make efficient use of the trimmers, it is important that they always have material at hand so that they do not stand idle. The "merry-go-round" type of conveyor has been found especially good for maintaining a steady supply of vegetables and fruits. One design consists of three parallel belt conveyors with the center belt positioned above the other two so that its return (or bottom side) is at the same level as the top side of the other belts. The top sides of the three belts travel in the same direction. The outer belts carry the untrimmed material to the trimmers. Any vegetables that are not picked up by the time they reach the end of the belts are diverted to the bottom side of the center belt by a diagonal bar. The center belt returns them to the beginning of the line where the vegetables are again diverted to the outer belts. The trimmed material is placed on the top side of the center belt by the trimmers and continues on to the next operation.

Waste trimmings may be handled by either of the following methods:

1) Each of the outer belts of a "merry-go-round" conveyor is divided into two lanes by a steel strip suspended over the belt. The inner of these lanes is used to supply untrimmed material; the outer, to carry off the waste.

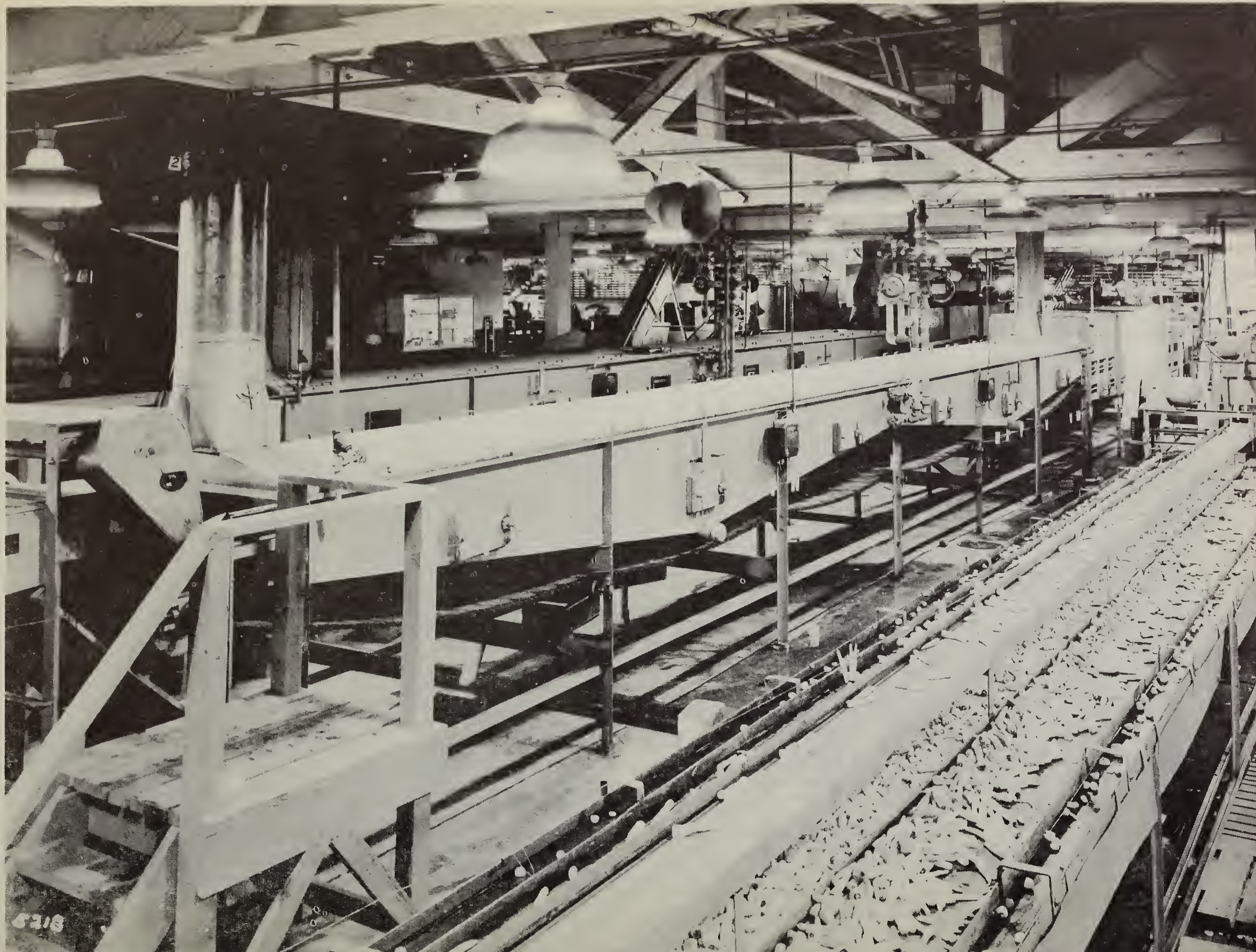
2) Chutes may be placed along the sides of the conveyor. These lead either to the return side of the outer belts or to gutters or flumes in the floor to carry off the waste.

E. Washing

Post-trimming washing insures that the product is clean before it is further processed. This washing can be done in rotary or tank washers or in various other ways including water sprays located over conveyors, elevators, or chutes.

F. Cutting (slicing, dicing, stripping, shredding, etc.)

Most products are cut before they are dehydrated. This cutting serves two main purposes: (1) to facilitate cooking, blanching, and drying, and (2) to allow the dehydrated product to be rehydrated easily when prepared for food use. Satisfactory commercial equipment is available for cutting vegetables and fruits into dice, slices, shreds, or strips. As a safeguard against serious damage to cutter knives, precautions should be taken to remove rocks, bolts, nuts, nails, etc., from the raw material being processed. Knife sharpening facilities are essential in a dehydration plant.



PREPARATION AREA SHOWING MERRY-GO-ROUND TRIMMING CONVEYOR AT LOWER RIGHT AND BELT BLANCHER IN MIDDLE OF PHOTOGRAPH

G. Blanching or cooking (includes any sulfiting, or other treatment associated with the blanching operation)

Of the commodities considered in this Handbook, beans, beets, cabbage, carrots, peas, potatoes, and sweetpotatoes must be blanched. In one common method, the prepared product is loaded directly onto the belt of a continuous belt blancher or on the drying trays. The belt or trays, loaded with the product, travels through an enclosed section which is fitted with steam nozzles, both above and below the product, throughout its effective length. The nozzles should be arranged in such a manner as to avoid blowing the product off of the belt or trays. Among the factors that may influence the required blanching time are the following:

1) Size of pieces. Since the product should reach a temperature of at least 190°F. in the center of each piece, it is obvious that the larger the piece, the longer will be the time to reach this temperature.

2) Depth to which the material is loaded on the blanching trays or belts. The greater the depth of load the longer will be the time required for penetration of heat to the center of the load.

3) Uniformity of distribution of heat in the blancher. If there are pockets or areas in the blancher in which the temperature is low, a longer time will be required to compensate for the low temperatures. If possible, these pockets or areas should be eliminated by making the necessary changes in the equipment.

4) Adequacy of the steam supply to maintain a high temperature. If the temperature should drop, a longer time will be required to obtain the desired degree of blanch. Entrance of air to the blanching chamber through leakage or drafts will cause reduced temperatures in the blancher.

5) Characteristics of the raw material. Variety and maturity of the commodity are important in determining correct blanching time. Immature material generally requires less of a blanch than mature material.

It is important that cut material be spread evenly over the belt or trays to insure uniform blanching. Various feeding and spreading devices are used, such as vibrating feeders, rotating spreaders, and straight, curved, or angular stationary bars.

Screw blanchers have recently come into use and have proved very successful for such products as potato and carrot dice. The units are essentially screw conveyors with steam injection manifolds attached to the bottom. Condensate drains may also be provided along the bottom. Advantages over belt blanchers include lower initial cost, lower maintenance cost, less floor space, easier cleaning, and agitation of the product during blanching. Screw blanchers have not been adequately proved to be recommended for fragile products.

Of the commodities considered in this Handbook, apples, beans, cabbage, carrots, peas, potatoes, and sweetpotatoes are sulfited. The procedure that has been commonly adopted for the vegetables involves applying the sulfite in a spray either in the blancher or immediately following the blancher. The sulfiting should be done with spray nozzles so that a good distribution of the sulfite solution will be obtained. Some plants have tried to apply sulfite by allowing the solution to run out of holes drilled in a pipe, but this method gives poor distribution and hence poor sulfiting results. A pump should be provided to deliver the sulfite solution to the nozzles at suitable pressure. Adequate drainage is needed after blanching and sulfiting to remove excess sulfite solution from the commodity before it is loaded on trays or belts for drying.

Blancher surfaces coming into contact with the material should be made of stainless steel. The additional cost of stainless steel is well justified as less corrosion and longer equipment life will result, smooth and continuous operation will be assured, and rust contamination of the product will be eliminated.

Solutions for sulfiting vegetables before dehydration are generally made up from sodium sulfite and sodium bisulfite salts in approximately equal proportions. Solutions of sulfur dioxide gas in water are also used successfully, but require frequent laboratory control checks.

Sulfiting has also been accomplished in direct-fired dryers by the burning of sulfur-bearing oils. Control of the sulfite content of the product requires definite knowledge of the sulfur content of the fuel and drying conditions. Under one set of drying conditions 0.2% sulfur in the oil gave potato dice the desired sulfite content.

CHAPTER X

DRYING, PRODUCT FINISHING, AND PACKAGING OPERATIONS AND EQUIPMENT

240. Drying

The principles of drying are discussed briefly in Chapter II. The reader will find a more complete discussion in AIC-300, Principles of the Drying Process with Special Reference to Vegetable Dehydration, by W. B. Van Arsdel, Western Regional Research Laboratory, United States Department of Agriculture, Albany, California, 1951.

Types of Dryers

The following types of dryers have been used commercially or may be adaptable for the various products considered in this Handbook. The discussion of each type of dryer gives details on its uses and limitations.

For feed material in piece-form:

- Tunnel
- Conveyor
- Belt trough
- Bin
- Vacuum shelf

For feed material in mashed or granular form:

- Pneumatic conveying
- Fluidized bed

For feed material in liquid form:

- Drum
- Vacuum shelf
- Vacuum belt

A. Tunnel dryers

1) Classification of tunnels

One customary drying practice is to put the prepared vegetable or fruit on trays, which are stacked on small cars or trucks and put through tunnel dryers. Heated air is circulated through the tunnels to achieve drying by either of the following common methods.

a) One-stage counter-current drying: In this system the heated air is forced, by blowers, through the tunnel in the direction opposite to that which the cars travel. Thus the incoming heated

air comes into contact first with nearly-dried product, and as the air travels through the tunnel it comes into contact with trucks carrying increasingly wetter pieces of the commodity. The evaporation of water from the commodity pieces requires heat, and this is furnished by the heated air. The air, becoming cooler as it vaporizes water, has a decreasing ability to vaporize moisture as it travels toward the end of the tunnel.

The temperature of the air entering the tunnel, in counter-current flow, is limited by the relatively low temperature that the dried product can tolerate without heat damage. The permissible temperatures range from 130° to 170°F, depending on the product. Operating conditions are usually established so that the material is dried to approximately 10% moisture content if the product is to be given a final drying in bins.

b) Two-stage drying: In the first stage, the heated air travels in the same direction as the loaded cars -- this is known as parallel flow. Much higher initial air temperatures can be used, often in the range of 180° to 200°F., than in counter-current flow, as the heated air first comes into contact with the wettest commodity pieces. Thus, a very high moisture evaporation rate is achieved in the first stage. The usual practice is to remove 60% to 80% of the water in the original material in this stage.

After leaving the first stage, the cars are put through the second stage, which has a counter-current arrangement similar to that described in (a) above. The product is dried to approximately 10% moisture in this second stage if the product is to be given a final drying in bins.

In general, two-stage drying is faster and permits more flexible operating conditions than the single stage counter-current type.

2) Design of tunnels

Certain features of tunnel dryers have been standardized. Most have 3' x 6' trays with about 25 trays per car. Most of the recently built tunnels have walls made of hollow building blocks or concrete "tilt-up" slabs. Interior dimensions of tunnels are nominally 7 feet high by 6-1/4 feet wide and vary in length from 40 to 70 feet.

Tunnels may be built as "singles" in which each drying chamber is served by a combustion chamber and fan, or as "twins" in which two drying tunnels are served by one combustion chamber and one fan. "Twin" tunnels are more common. To equalize air flow into each tunnel of a "twin" arrangement, the number of cars in each tunnel must be the same or dampers must be used to control air flow into each tunnel. This problem normally is not serious in a plant operating at maximum production.

ROW OF SIDE-FIRED DRYING TUNNELS SHOWING LOCATION OF BURNERS, CARS IN ENTRANCE TO TUNNELS, AND TRANSFER TRACK

(Courtesy of J. R. Simplot Co.)

An important point in design is the choice between side-firing and overhead-firing. Side-fired tunnels are built with the fan and combustion chamber between the drying chambers. Overhead-fired tunnels are built with the fan and combustion chamber above the drying chambers. Both types have been satisfactory in industry.

Advocates of the side-fired tunnels claim:

a) Better air distribution at the hot end of the tunnels

b) Firmer foundations on which to set the combustion chamber and fan

c) Easier access to the burners for adjustment

Advocates of the overhead-fired tunnels claim:

a) A savings of about 30% in floor space is accomplished

b) Equally good air flow can be attained by proper design

c) Adequate support for overhead fans and combustion chamber is provided by a hollow block wall reinforced adequately with steel

Recent plant constructions tend to favor the overhead design.

The trucks on which the trays are usually carried may be moved about the plant on rails or channels, or directly on a smooth floor, or carried by lift trucks. Three types of wheels are used on the tray-trucks: (a) a flanged wheel that runs on steel rails, (b) a grooved wheel that runs on inverted angle-iron rails, found to be self-cleaning, and (c) a flat-faced wheel that runs on either flat surfaces or in channel irons. For type (a) the rails required for carrying cars are set in the floor, so they should be installed when the concrete floor is poured. To move cars at right angles to their line of movement in the tunnels, turntables or transfer cars and tracks are used. Grooved wheels can also be run on flat surfaces.

Types (b) and (c) permit a simpler installation when tunnels are to be built on existing floors. Also the conversion of a dehydration plant to other use is easier as there will be no major problem of removing the steel rails, since they are not imbedded in the floor, or of filling in the transfer track areas.

For further discussion of tunnel dehydrators, the reader is referred to AIC-308, Tunnel and Truck Dehydrators as Used for Dehydrating Vegetables, by W. B. Van Arsdel, Western Regional Research Laboratory, United States Department of Agriculture, Albany, California, 1951.

3) Tray loading

Several types of trays are generally used: (a) wood construction throughout, (b) wood frames with wire-mesh bottoms, (c) wood frames with perforated stainless steel bottoms, and (d) aluminum frames with either solid or perforated aluminum sheet bottoms. Other variations, of course, are likely to be produced. Some trays have been made of various types of plastics, but none has been used extensively.

The most common size for the all-wood and wood-frame trays with wire-mesh bottoms is 3' wide by 6' long, although some processors use 7' long trays. One processor uses 36" x 42" wood-frame trays with perforated stainless steel bottoms. The all-aluminum trays can be obtained in both standard (3' x 6') and approximately half-size dimensions.

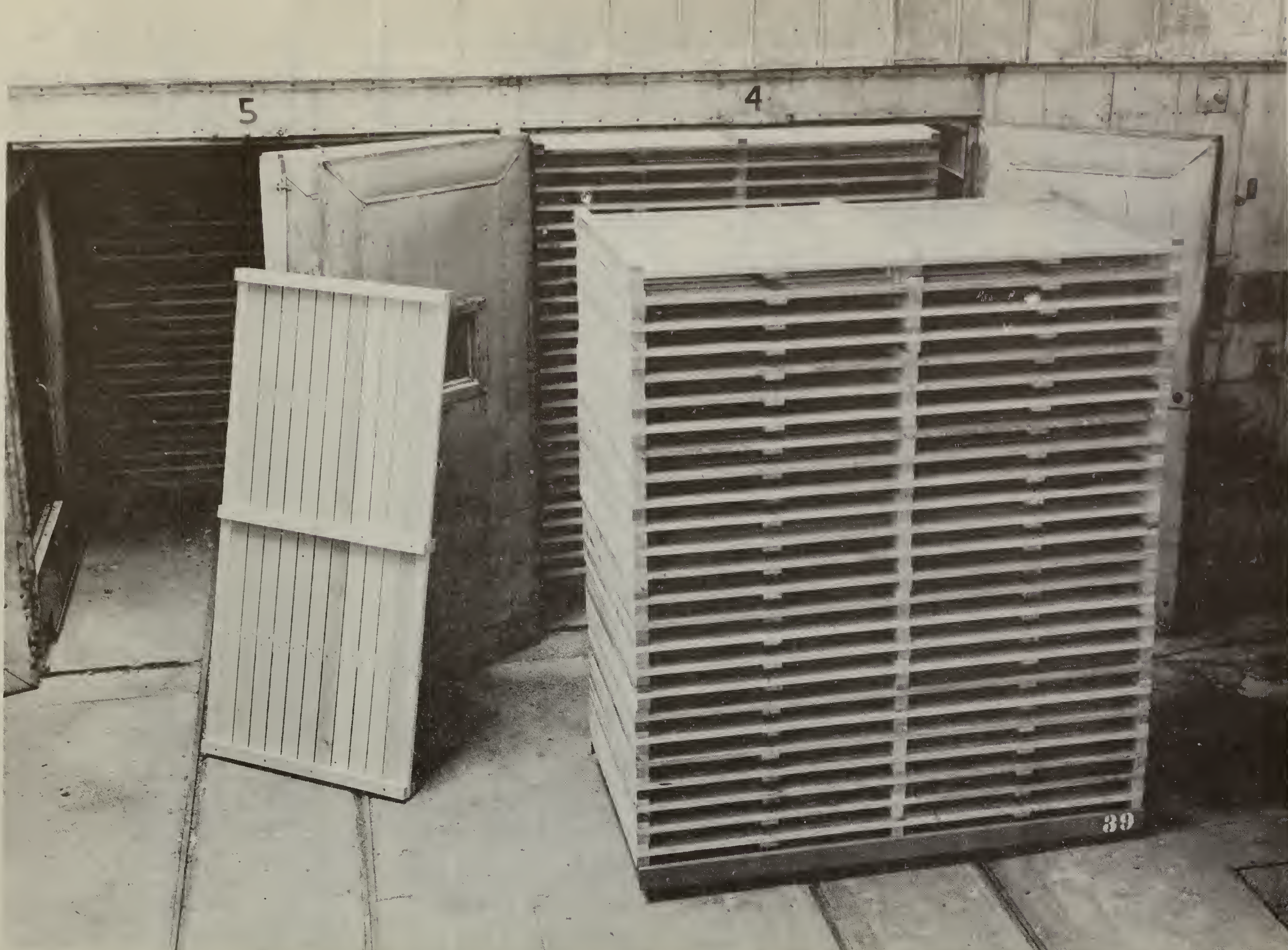
The all-wood tray life ranges from one to three years, depending upon products dehydrated, loading weights, frequency of use, method of washing, method of stacking and unloading, and care with which they are handled. Trays consisting of a wood frame and perforated stainless steel bottom have a useful life ranging from five to ten years.

Although wooden trays are the most popular in the dehydration field, their main drawback is contamination of the product with wood splinters which must be removed during final inspection.

Various oils, waxes, and emulsions are in current use as water-proofing agents in an endeavor to extend tray life and to reduce stickiness in both the wood and metal trays. Some processors use no preservative on wooden trays.

In order to achieve uniform drying, it is necessary that the cut material be loaded evenly on the drying trays. Material on lightly loaded areas will dry quickly and may scorch, and that on areas loaded too heavily will not dry sufficiently. Tray loading, therefore, is a critical operation which warrants careful attention.

A vibrating chute has been found most satisfactory to spread diced material uniformly across the full width of the trays. Other arrangements have been adapted for material cut in shreds or other forms. The speed at which trays move under the spreader should be readily adjustable so that their speed can be matched to the feed rate of the material. Provisions should be made for keeping cut material off the tray frames since such material will tend to become scorched during the drying operation, or may be caught between the trays as they are stacked on the truck.



WOODEN DRYING TRAY AND CAR LOADED WITH TRAYS, STANDING AT THE ENTRANCE TO THE DRYING TUNNELS
(Courtesy of Gentry Division, Consolidated Grocers Corp.)

4) Tray stacking

As trays come off the tray loading conveyor they are stacked onto trucks. During World War II most of this stacking was done manually. More recently, commercially-available automatic tray stackers have been proved very successful.

5) Weighing

As a check on tray loading and material throughput, loaded trucks may be weighed on a scale recessed in the floor.

6) Tunnel operating

Fuel economy is realized by recirculation of some of the drying air, but product output is lowered. Some tunnels are run without recirculation at any time in order to simplify the job for tunnel operators. If this practice is to be followed, tunnel design may be simplified.

7) Tray unloading and stacking

This operation may be performed manually or mechanically. In semi-automatic equipment the tray handling is done manually and the tray scraping is done mechanically by a rotating blade or brush. Semi-automatic equipment does not reduce materially the labor requirement for medium-sized plants, but it will assure a uniform scraping of trays. A semi-automatic type of tray scraper is available as a standard equipment item.

Fully automatic equipment unloads the trays from a truck, removes the dry product from each tray, and replaces the trays on a truck. The fully-automatic unit has not been manufactured as a standard unit, however.

8) Tray washing

In industry the frequency of tray washing varies from three or four times a season to each time the trays are unloaded. If trays are to be washed when the plant is not in operation, it can conveniently be done in the line in front of the stacker.

If trays are to be washed while the plant is in operation, a special tray-washing line might be set up; or more desirably, provision may be made in the regular line for washing trays between the point where the trays are fed to the line and the point where material is loaded onto the trays.

Several methods of tray washing are in use:

a) Washing down with a hose and hot or cold water

b) Spraying the trays with water from banks of nozzles placed above and below the tray level on a conveyor belt

MANUAL TRAY STACKING
(Tray loading and spreading in background)
(Courtesy of Basic Vegetable Products, Inc.)

TRAY UNLOADING AND STACKING
(Courtesy of Basic Vegetable Products, Inc.)

c) Cleaning inverted trays with rotary brushes used in conjunction with soap, steam, and hot water sprays

d) Scrubbing with hand brushes and hot water, which is considered by some as doing the best job

B. Belt-conveyor dryers

Continuous belt-conveyor dryers are finding increased usage for certain vegetables and fruit products. In this system the prepared fresh commodity pieces are spread continuously on a moving belt which slowly travels through a drying chamber. This method has four important advantages over ordinary tunnel drying:

1) Less operating labor

2) Less floor space

3) Shorter drying time

4) Under normal operating conditions, more uniform drying of the commodity pieces (better circulation of the heated air around the pieces, and the pieces can be turned over during the drying process)

Belt-conveyor drying has two principal disadvantages compared with tunnel drying:

1) Higher installed cost

2) Greater requirement for critical metals

The belt-conveyor dryer is fundamentally automatic and continuous in operation and may therefore be preferred in a mechanized plant. A relatively thick layer of commodity, usually 3" to 6" is carried on the conveyor belt. The belt area is usually eight to ten feet wide, and varies in length from about 60 to over 100 feet.

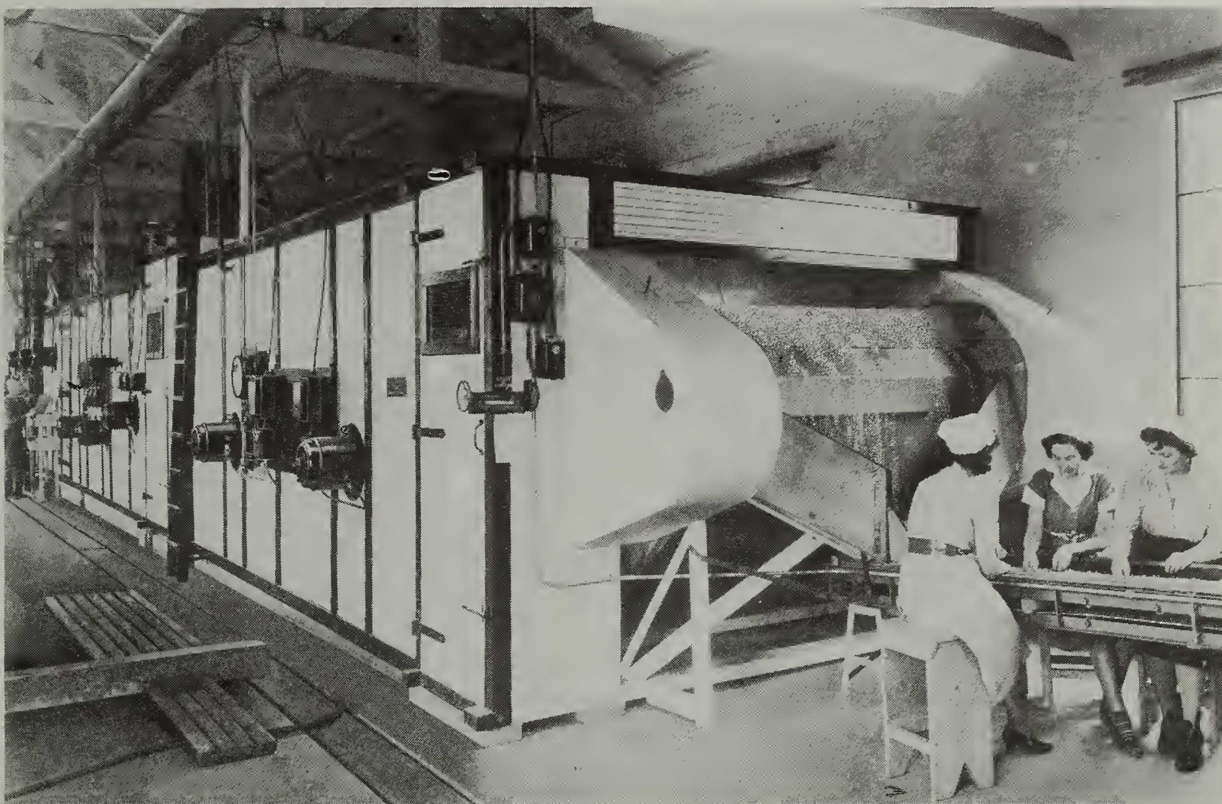
Drying a thick layer of moist material is practicable only if the flow of air is through the layer. Belt-conveyor dryers are therefore built for through-circulation of air. Special precautions must be taken to assure uniform loading of the conveyors and to avoid packing and/or matting. Product which is heavily loaded or tightly packed will not have normal air circulation and will not dry adequately. Product which is lightly loaded will be blown aside and blow-holes in the bed will result.

Belt-conveyors are usually operated continuously as voids in the bed of materials cause short-circuiting of air through the open spaces.

The belt-conveyor dryer is probably not as flexible in its operation as the tunnel dryer and probably cannot be used on as many different commodities. The belt-conveyor dryer has been used very successfully for piece-form items such as apples, beets, carrots, onions, potatoes, and

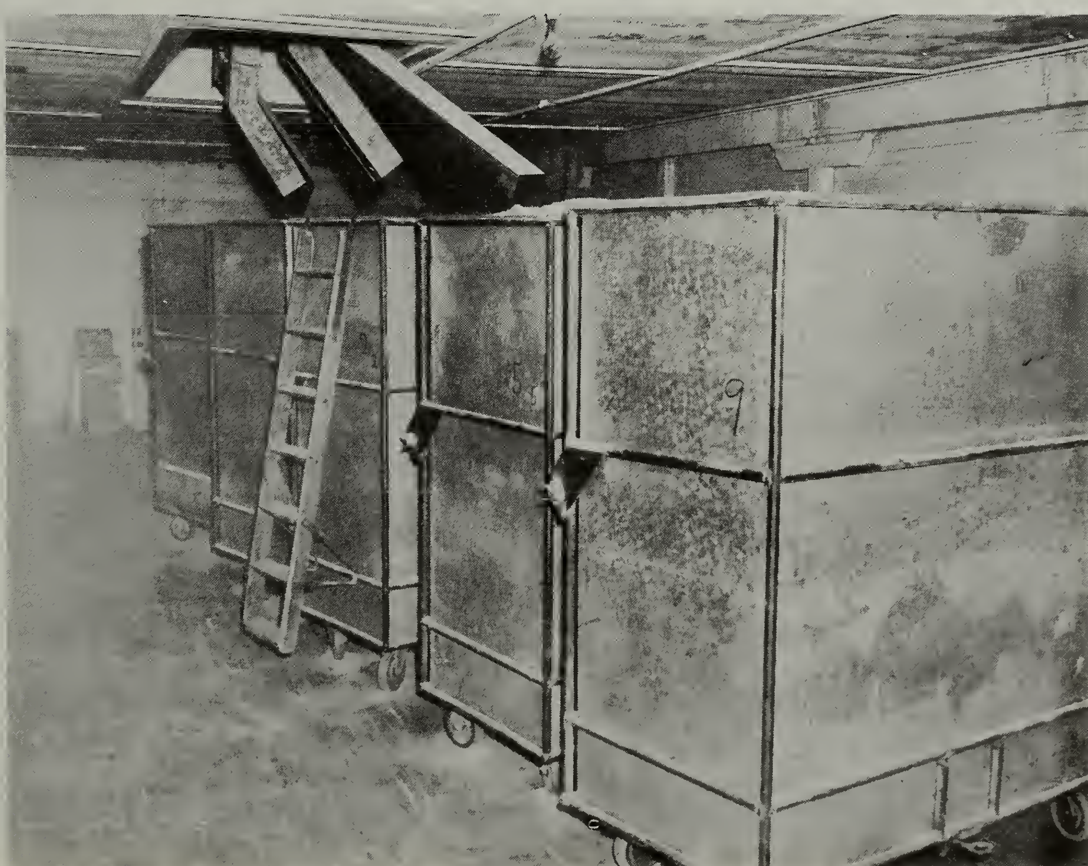
CONVEYOR DRYER AT DISCHARGE END

(Courtesy of Proctor & Schwartz, Inc.)



PORTABLE DRYING BINS

(Courtesy of Idaho Potato Growers, Inc.)



sweetpotatoes. The dryers must be cleaned periodically in addition to the usual scraping and cleaning of the belts during operation. The belts may be treated or coated with wax to reduce sticking of the product and to decrease the frequency of cleaning.

C. Belt-trough dryers

The belt-trough dryer is a recent addition to the types of dryers available for vegetable and fruit dehydration. It was put into commercial operation in 1957. While the dryer is still in the evaluation stage for many products, it appears that this dryer will eventually be used for a wide range of materials which are in piece form and have a firm texture. The dryer is normally operated as a continuous unit, but it can also be operated batchwise if desired.

The dryer consists essentially of a wire-mesh belt running on sprockets mounted on 3 drive shafts. The belt is supported during part of its path of travel so as to form a trough, with the bottom of the trough resting on an inclined, flat-surfaced air grate. The material is continuously cascaded in this trough while a current of hot air blows up through the grate and bed of material. The tilt of the bottom of the trough is adjustable both laterally and longitudinally to control the movement of the material as it tumbles in the dryer. The wet material is normally fed at one end of the trough and the dry product discharges over a weir at the other end. The trough size for commercial units is 4' wide by 10' long. Advantages of the belt-trough dryer are:

1) Slow, constant agitation of product which results in uniform drying

2) High operating temperatures, which result in high thermal efficiency and low fuel costs

3) Minimum floor space requirement

4) Low labor requirement

5) Rapid drying which results in better reconstitution of product

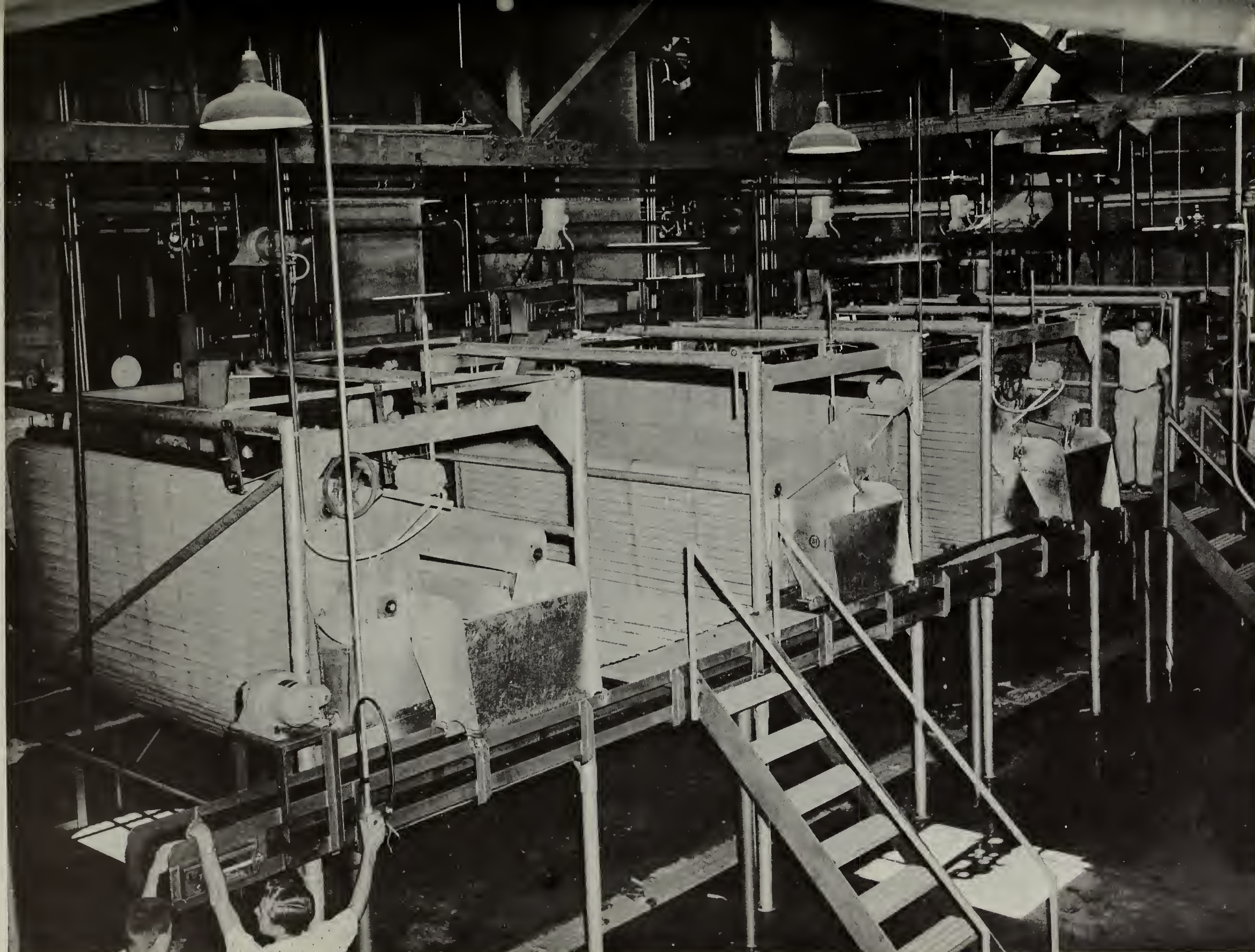
D. Bin dryers

After the major drying operation, the dried products (containing approximately 10% moisture) are usually given a further drying and equalizing treatment preceding packaging. Bin dryers are commonly used for performing this operation for piece-form products.

Bin drying serves several purposes:

1) Bins provide a cheaper means of removing water during the final and slow drying stage

2) The final moisture content of the finished product is equalized so that each piece contains approximately the same percentage of moisture



BELT - TROUGH DRYERS

(Courtesy California Vegetable Concentrates, Inc.)

3) Bins provide means for more closely controlling the moisture content of the finished product

4) Capacity and flexibility of preceding drying operations are improved by the use of bins to complete drying

5) Bins act as a storage reservoir for the packaging department

The bin dryer is essentially a metal or wooden box equipped with an air inlet at the bottom so that warm dry air can be passed through the nearly-dry bulk product. Interior dimensions are in the range of 3 to 4 feet wide, 5 to 8 feet long, and 5 to 6 feet deep. The screen on which the product rests should be quickly removable for both ease of cleaning and ease of replacement if it becomes damaged. Sloping bottoms should not be used on bins because of difficulty of getting even air flow throughout bins.

The present dehydration industry uses both fixed and portable bins for final drying. Portable bins have several advantages. They have great flexibility and convenience in operation, are less expensive and easy to construct, reduce the handling and conveying of material and thus minimize production of fines, and are easily cleaned. The contents of a bin are dumped into a hopper by up-ending the bin. For this purpose an electric hoist or lift-truck is used.

Fixed bins require less floor space, labor, and maintenance, and can be larger in size. Product movement into and out of fixed bins is usually by conveyor. The bottom of the fixed bin can be opened to permit product to fall onto the conveyor below.

Either steel or plywood makes satisfactory bins. Steel is recommended, if available, as it is more durable and prevents contamination of the product with splinters.

In areas of relatively high humidity it may be necessary to dehumidity the air entering bins. In order to reduce the investment in dehumidifiers, it may be desirable to use dehumidified air directly in only half of the bins, the remaining half using air recirculated from the other bins or using outside air directly. Thus the product coming from the primary dryers is dried first in the section using the recirculated or outside air, and then the product is finished in the section using dehumidified air.

E. <u>Other types of dryers</u>

1) Vacuum dryers

Because of the higher cost of vacuum dryers, they have been used only for products which are difficult or impossible to produce by other methods of drying. Depending on the type of product being handled, the degree of mechanization desired, and other factors, the equipment for vacuum drying is of various designs.

Vacuum shelf dryers have been used for low moisture apples for many years. Air dryers have been found to be feasible however and are being used for part of the production of this product. Continuous vacuum belt dryers have been used for the production of citrus powders.

2) Pneumatic conveying dryers

Pneumatic conveying dryers of various designs are used for the primary drying of potato granules. In these dryers the granules are conveyed and dried by a stream of hot air. Separation of the product from the air is accomplished in cyclone collectors.

3) Fuidized-bed dryers

Fluidized-bed dryers are used for finish drying of granules. Heated air entering through a porous bottom keeps the granules in a turbulent state and accomplished uniform drying with minimum product damage.

4) Drum dryers

Drum dryers are used for the production of powdered dehydrated cranberries. Pureed, cooked berries are dried on the outside surface of a heated rotating drum.

Comparison of Tunnel and Conveyor Dryers for Piece-Form Products

Some differences in the characteristics of finished products may be expected as a result of the type of dryer used. Conveyor dryers, which allow use of higher temperatures and shorter drying times, often produce a more porous and bulky dried product than do tunnel dryers. This greater porosity makes reconstitution of the dried product faster and more complete. The greater bulk may cause difficulty, however, in getting the specified weight into cans.

Initial investment and use of critical materials normally will run higher on conveyor dryers than on tunnel dryers of the same capacity. The higher initial cost of conveyor dryers, however, may be offset by savings in labor and floor space.

Western processors used tunnel dryers almost to the exclusion of conveyor dryers until recent years. Some potato dice and onion dehydration plants are now using conveyor dryers, having found that the additional investment is justified by savings in labor at current labor rates over long operating seasons. Eastern and Southern processors have used both types. Currently conveyor dryers are more popular.

Either type of dryer can be built with one or more drying stages. The use of more than one stage permits the use of higher temperatures during the initial part of the drying cycle when the product is moist. However, multistage operation is more complicated.

One company has built most of the conveyor dryers now used in the vegetable dehydration industry. Its plans are standardized and the dryers are usually built with more than one drying stage. These dryers have been satisfactory when properly operated. Detailed information on design features of conveyor dryers can best be obtained directly from the equipment manufacturers.

Tunnel dryers for vegetable dehydration have been built by many different companies and the designs have not been standardized. One-, two-, and three-stage units have been used in industry. Most of the products covered in this Handbook may be dried satisfactorily in any number of stages. For an emergency plant that is to be operated when competent workers may be scarce, the use of three or more stages does not seem justified. For commodities that will not stand a high final drying temperature (onions -- not over 135° to 140°F.) or for those that have a very high percentage of water that can be removed rapidly (cabbage), two-stage tunnel dryers are preferred to single-stage units. For other commodities which have lower initial moisture content and will stand a reasonably high final drying temperature, the choice between one- and two-stage tunnel dryers becomes more an arbitrary decision.

Sources of Heat for Dehydration Use

The heat required for dehydration may be applied by several means including hot air, surfaces heated by steam or hot water, and radiation. Electrical heating is too expensive for most drying. For the products considered in this Handbook, this method is used only as a minor auxilliary source on citrus powders being dehydrated in continuous dryers. Steam heat is used on drum dryers and in some vacuum dryers. Hot water is commonly used in vacuum shelf dryers. Most vegetable and fruit products are dried by the use of hot air.

Heating systems for most air dryers can be divided into two broad classifications: (1) direct combustion heating, and (2) indirect heating. With direct heating, the gaseous products of combustion are mixed with the drying air and thus come in direct contact with the product. An open gas flame in the main air stream of the dryer is an example of this type of heating system. With indirect heating, the combustion gases do not mix with the air used for dehydration. Heating surfaces are used to transfer the heat from the heat source to the drying air. A dryer using steam heating coils is an example of indirect heating.

1) Direct combustion heating is commonly used in tunnel and in pneumatic conveying dryers. Since there are no transmission losses, maximum heating efficiency is possible. The fuel used is usually either natural or manufactured gas, bottled gas, or fuel oil. Gas is usually preferred to fuel oil because of ease of handling and the simplicity of control equipment, and because the products of combustion are not likely to affect the quality of the product being dried. Fuel oil has been used by some dehydrators, but considerable care must be exercised to avoid oils of high sulfur content. Fuels with high sulfur content cannot be used satisfactorily in direct combustion dehydrators, particularly potato granule dryers, because the product picks up excessive sulfur

dioxide liberated during combustion. The sulfur content of fuel oils, as usually marketed, is not closely controlled. As a result, the risk of contaminating the product with excessive sulfur dioxide varies from one batch of oil to the next, unless the dehydrator operator buys fuel oil of definite low sulfur content.

Gas burners should be of the pre-mix type, installed in accordance with the recommendations of the National Board of Fire Underwriters. Burners are installed directly in the dryer air stream and are sometimes shielded from the cooling effect of the surrounding air currents by a simple unlined sheet metal combustion chamber built around the burner.

Oil burners should be installed in accordance with the Underwriters' recommendations. Fuel oils cannot be burned satisfactorily as an open flame because the chilling effect of the surrounding air current will cool some of the atomized oil particles below the ignition point. These particles do not burn completely and form smoke and soot which contaminate the product in the dryer.

A satisfactory way of burning fuel oil is in a refractory-lined steel-shell combustion chamber divided into a primary and a secondary combustion zone by a refractory checker-brick partition. The partition serves to confine the radiant heat to the primary zone. In operation this primary zone becomes incandescent, so that combustion of the fuel is practically complete. The checker-brick partition also serves as a baffle which largely prevents the escape of unburned oil droplets, since impingement of the droplets on the incandescent bricks results in combustion of the fuel.

The secondary zone is an added precaution against smoke because of incomplete combustion. Any unburned particles of oil escaping from the primary zone will burn at an accelerated rate when they come into contact with the high velocity, high temperature gases flowing through the checker-wall restrictions. The oil particles have sufficient time in the secondary zone to burn completely before entering the main air stream.

2) Indirect heating systems for dehydrators involve, in most cases, steam-to-air heaters, although combustion gases-to-air heaters are found particularly in apple dehydrators. Steam-to-air heaters, or steam heating coils, are used in conveyor, bin, tunnel, and pneumatic conveyor dryers. The principal advantage of using an indirect heating system is that the risk of contaminating the commodity with the products of combustion is completely eliminated, because the combustion gases are isolated from the drying air. One of the normal products of combustion is moisture vapor. In direct-heat dryers, this moisture added to the air by the combustion gases may seriously reduce the drying rate or may limit the moisture content to which the finished product can be dried. Indirect heating of the air is, therefore, advisable for bin drying, particularly if the product is to be dried to a very low moisture level.

The principal disadvantages of using an indirect heating system are the additional equipment required and lower heat efficiency. If oil is used, the cost of the fuel may be no greater than for direct heating because cheaper grades of oil can be used in an indirect heating system.

Control Devices For Air Dryers

Instruments used in the drying operation include as a minimum (1) temperature controllers to regulate automatically the dry-bulb temperatures of air in each stage or section of the dryer, and (2) thermometers to check dry-bulb and wet-bulb temperatures (these two temperature readings indicate humidity conditions in the dryer). A better set-up would include continuous recording of dry-bulb temperatures, and in some cases, continuous recording of wet-bulb temperatures.

Temperature controllers for use in air-drying equipment are usually modulating or throttling control type. These range from simple and inexpensive non-indicating type units to complex electronic-pneumatic instruments. The non-indicating controllers are generally used in conjunction with a separate temperature recorder. Commonly used instruments, which both record and control, are the filled-bulb, air-operated recorder-controllers. This type of instrument is capable of controlling temperatures very accurately when properly installed and adjusted, but is much more expensive than the simple non-indicating type of controller. Many operators consider the more accurate instrument necessary only when temperature control is critical, for example, in the operation of dryers at comparatively high temperatures.

Fans or Blowers For Air Dryers

Fans or blowers commonly used in air dryers are of three different types: propeller, axial-flow, and centrifugal. Propeller fans are best used where resistance to air-flow is low. Axial-flow and centrifugal fans are best used where both the air velocity and the resistance to air-flow are moderate or high, as in conveyor and tunnel dryers, but centrifugal fans are usually more efficient. The axial-flow type is often used because of its compactness and ease of installation and maintenance.

Propeller and axial-flow fans are somewhat similar in appearance. Both have disk or air-foil section blades mounted on a central shaft. One difference is in the fan housing. The housing of the propeller fan is usually a simple panel with a circular opening cut to fit the fan wheel. The axial-flow fan wheel is mounted in a cylindrical tube. The tubular housing is partially responsible for the good pressure characteristics of this type of fan. In some axial-flow units, stationary vanes are installed at the intake and discharge, to improve the efficiency by minimizing the swirling motion of the air stream leaving the fan.

A centrifugal fan, sometimes referred to as a "squirrel-cage", consists of a fan wheel within a scroll-type housing. The curve of the blades on the wheel may be sloped in various manners depending on the operating characteristics desired. For use in most dehydrators, the blades are sloped backwards. This feature gives a fan that does not overload, if the pressure drops. Pressure drops occur in dehydrators when the doors are opened or loadings are reduced.

250. Product Finishing

A. Screening

Specifications for some of the commodites considered in this Handbook require that not more than a certain percentage by weight of the packaged product may pass through a screen of specified mesh. Screening is therefore required to remove the fine material. The small pieces that pass through the screens are called fines. Some fines are produced in the normal operation of a dehydration plant. Extreme care should be exercised in the operation of the cutters and in the handling of the dried product to minimize production of fines since this fraction usually represents a financial loss to the operation. Some dehydrated products, especially onions and cabbage, are warmed to minimize brittleness and production of fines during packaging.

B. Inspecting

After the finished product has passed bin drying (and screening operations if used) it is inspected for discolored pieces and for the presence of any foreign material such as wood splinters. Inspection is done while the dehydrated product is carried along on a continuous belt. Inasmuch as this is the last opportunity for the operator to insure that the product to be packaged is satisfactory, it is important that this final inspection operation be carried out carefully. The material should not be spread too thickly on the inspection belt, and the belt should not travel too rapidly. Adequate lighting and space on the inspection belt must be provided for each worker to do a careful job of inspection.

The dried product may contain small pieces of iron or steel which have been picked up during processing and which may escape observation on the inspection belt. Therefore, a magnet should be provided to remove this "tramp" iron before it reaches the packaging line.

Electronic sorting machines are being used on some small piece-form products, such as potato dice. The machines inspect each piece for color and eliminate those pieces that are appreciably off-color. The probable lack of availability of electronic sorters and skilled repair service required for their operation may prevent their use in emergency plants.

For final inspecting and packaging rooms, dehumidified air may be required to prevent moisture pick-up by the dehydrated products.

260. Packaging and Packing

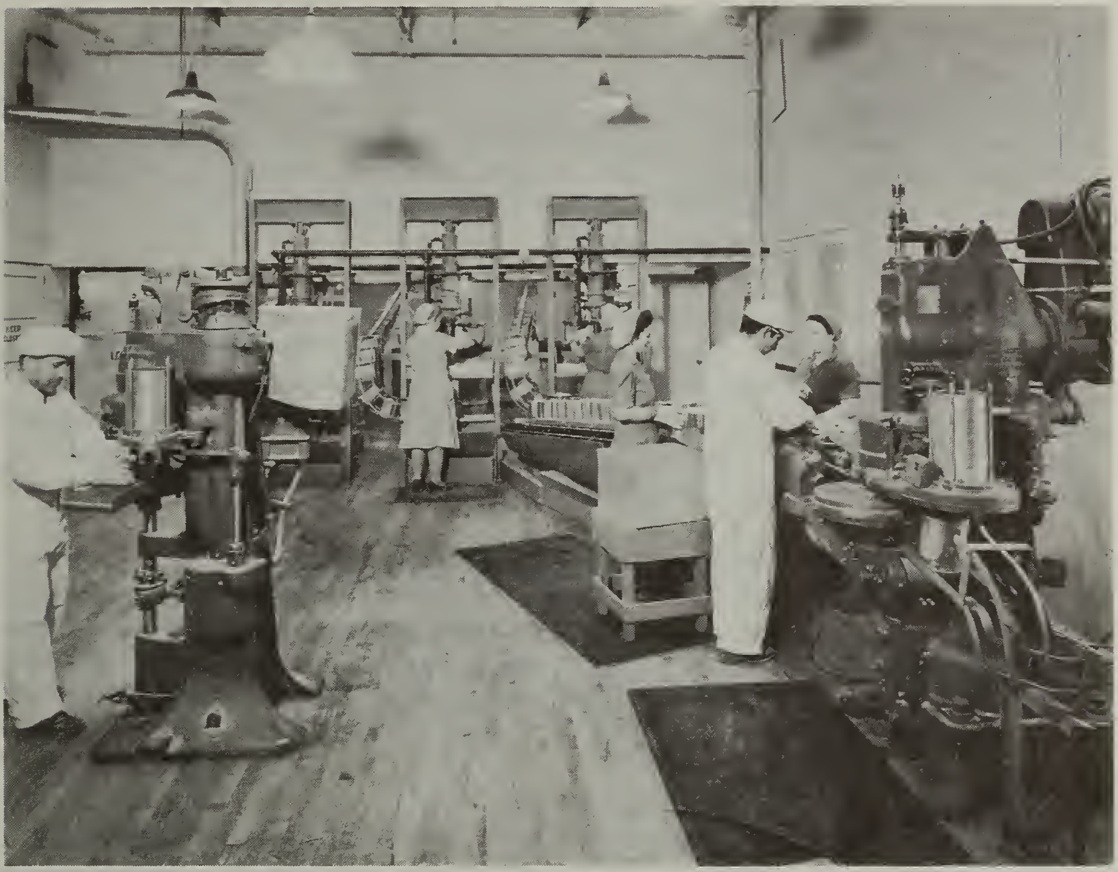
A. Can filling and sealing

The type of equipment used in filling and weighing varies from plant to plant in the dehydration industry. The number of containers needed for the finished dehydrated product obtained from a given quantity of raw material is much lower than for other types of food processing because of the great reduction in weight and bulk during drying. Expensive or complicated packaging equipment is usually not justified.

INSPECTING DEHYDRATED ONIONS
(Courtesy of Basic Vegetable Products, Inc.)

CAN FILLING, COMPRESSING, AND SEALING LINE

(Courtesy of Basic Vegetable Products, Inc.)



GAS PACKING LINE

(Courtesy of J. R. Simplot Co.)

Some of the commodities must be packaged in inert gas such as nitrogen. Two methods have been used. In one method the can is filled to the required weight, the lid is placed on the can, and the can is only partially sealed. The cans are then put into a chamber, and a vacuum is drawn on the chamber. After the desired evacuating time, the vacuum is relieved with inert gas which fills the cans. The cans are then removed and quickly sealed.

Another method involves the use of a lid with a small hole. After being filled, the can is sealed completely except for the small hole, and then placed in the gassing chamber. After the vacuum has been held as required, inert gas is introduced into the chamber and enters the can through the hole in the lid. When the can is removed from the chamber, the hole is immediately soldered.

B. Case forming, filling, sealing, and marking

These operations are standard and should present no special problem. Two factors that must be considered, however, are that (1) rate of output is relatively low, and (2) comparatively heavier casing materials are used for Military items.

270. Warehousing and Shipping

Pallets and lift-trucks should be provided to handle the cased goods. Warehouses with ceiling clearance of 14 feet permit the stacking of packed product three pallet-loads high, but higher ceiling height in the warehouse area is recommended to provide inexpensive additional storage space. The relatively light weight of palletized loads of dehydrated products permits higher warehouse stacking than is used for most other types of processed food.

An office and other facilities that may be required should be provided so that Quartermaster Inspectors can carry out their duties.

CHAPTER XI

MANUFACTURING SERVICES AND FACILITIES

300. GENERAL MANUFACTURING SERVICES

320. Utilities

A. Water supply

Operation of a dehydration plant is dependent upon an adequate water supply. Water may be used for washing, peeling and conveying of raw material, blanching, cooling, plant cleaning, steam generating, waste removal, and fire fighting. Several sources of water may be available to dehydration plants depending on particular locations. A company may either develop its own sources or purchase water from others.

Companies that develop their own systems usually depend on wells, but sometimes use surface water sources such as lakes or streams. Water may be purchased from municipalities, water companies, irrigation systems, or other private companies.

Companies with their own systems have the responsibility of maintaining the water quality necessary in food processing plants. Purchased water may not meet these quality standards without treatment; usually water from municipalities and water companies will.

The water should meet U. S. Public Health Standards for potable water. These standards specify permissible levels for various minerals, solids content, and organic and bacterial contaminants.

Water used for steam generation may require special treatment in order to protect the generating system, and to obtain clean steam for blanching or similar uses.

Some plants provide equipment for water chorination. This treatment improves plant sanitation by reducing bacterial and mold growths. Equipment and plant are thereby more easily kept clean. Reduction of slime on the floors reduces accidents.

B. Fuel supply

The facilities provided for fuel supply depend upon the type of fuel used. Oil, butane, or propane require storage tanks. Reserve storage capacity should be provided to take care of serious delays in receipt of these liquid types of fuels.

ELEVATOR AND HOPPER FOR HANDLING PROCESSING WASTES

(Courtesy of Gentry Division, Consolidated Grocers Corp.)

ONE TYPE OF CONSTRUCTION SUITABLE FOR A DEHYDRATION PLANT OR STORAGE WAREHOUSE

No storage facilities are needed for gas which is piped in, but some standby fuel service may be advisable for two main reasons: (1) to provide another fuel in case of some condition that may stop the supply of gas, or (2) to permit the purchase of gas at interruptible service rates. Interruptible type of service gives a plant the benefit of a low rate, but gives the gas company the right, in case of gas shortages, to stop supplying gas.

C. Electric power

Power is generally available in most sections of the country that would be considered for a dehydration plant. Only in exceptional cases would lack of sufficient power be a factor in plant construction or operation.

D. Steam supply

Plants commonly use fully automatic package boilers. Such boilers will have low installation costs and can be easily moved to another location. Three locations for the boiler are possible: (1) in the plant building proper; (2) in adjoining structure; or (3) in a separate building away from main plant. Each location has advantages and disadvantages, and each plant must determine which best suits its own conditions. If the boilers are located away from the main plant, some savings can be realized in insurance costs and in housing construction costs for the boilers. The boiler house should be located so that it will not obstruct expansion or rearrangement of processing line. Heat losses in the transmission of steam favor locating the boiler near point of greatest steam usage.

E. Waste disposal

Screening of liquid wastes for removal of coarse suspended solids is usually necessary. State and local ordinances regulate the mesh of screen to be installed. Solids from the screens, plus trimmings, rejects, etc., are held in bins until hauled away for disposal.

The screened waste water may be run into sewers, streams, irrigation ditches, seepage ponds, lagoons, waste land, or other facilities, depending upon what is available and upon local and State regulations. Treatment of screened waste water may be necessary in some cases before disposal.

330. Maintenance and Repairs

A. Shop equipment

The amount of shop equipment needed will depend largely upon the extent to which the dehydration plant must be self-sufficient in this respect. The existence of good, nearby repair shops will lessen the need for elaborate shop equipment at the plant.

In addition to the usual hand tools needed for carpentry, masonry, electrical, plumbing, and metal work, the shop may need other items: sheet metal cutting facilities; pipe threading and cutting equipment; and machine shop equipment. Equipment is also needed for cleaning up plant and grounds.

B. Parts and supplies

Practically no piece of mechanical equipment in the plant is free from the possibility of occasional breakdown. If good machine shop service and machinery supply houses are nearby, the plant inventory of maintenance parts and supplies need not be great. If they are not available, an inventory of essential items should be maintained.

Parts and supplies should include the following: motors, pumps, conveyor belts, switches, cutting machines, trays, trucks, pipe of various sizes, plumbing supplies, welding and brazing supplies, tanks of oxygen and acetylene, sheet metal and angle iron, an assortment of construction lumber, paints, electrical wire and conduits, and the various supplies needed for doing plant and grounds clean-up.

370. Packaging and Packing Supplies

The finished product warehouse space will probably also be used for storage of empty cans and cases. If shipments of finished product are frequent and regular, a larger proportion of the warehouse can be used for packaging supplies.

Upon signing a contract with the Government procurement agency, the operator must immediately arrange for purchase of all packaging and packing materials needed to fulfill the contract. Some items, such as metal cans, are usually delivered according to prearranged schedules so as to minimize storage requirements at the plant.

380. Inspection and Control

The producer of dehydrated vegetables or fruits deals with a perishable commodity throughout the handling of material from the field to the finished product. The product is accepted or rejected by the Military on the basis of rigid Specifications. Therefore, strict control of production operations is necessary to maintain a steady output of acceptable product.

The number of technical factors which must be controlled requires that the producer maintain a quality control department. This department must be adequately staffed with capable technically-trained personnel.

The functions of a quality control department are:

1) To conduct necessary laboratory tests on operations and products to make certain that Specifications are met

2) To maintain control over processing steps

3) To specify adequate plant sanitation standards

4) To provide service to field personnel (a) in formulating standards for acceptance of raw material, and (b) in controlling and inspecting raw material prior to processing

5) To determine shrinkage ratios, including losses incurred in the various processing operations

TESTING AND CONTROL LABORATORY
(Courtesy of J. R. Simplot Co.)

6) To carry out experimental and research projects covering new processes, products, and materials

The most essential product tests are discussed briefly in the following paragraphs. These and related tests that are made during processing operations provide the necessary basis for quality control over plant operations. Plant sanitation is largely a matter of good housekeeping, with limited amounts of bacteriological testing.

Moisture Content

A low moisture content is one of the most important factors in reducing the rate of spoilage of dehydrated vegetables and fruits. The maximum permissible moisture content is, therefore, always an important part of the Specification for a product. A moisture content substantially below Specification requirements may be desirable from the viewpoint of the purchaser to increase the useful life of the product. Because the drying rate is extremely slow below the moisture level required by Specifications, however, the producer seldom dries the product to a moisture content significantly lower than that required. In view of these considerations, a properly operating dehydration plant strives to make a product which is slightly below the moisture level required.

Different procedures for determining moisture content in dried vegetables and fruits give different results. For this reason, Specifications for these dried products not only specify the maximum amount of moisture permitted in a product, but also the method by which the moisture content is to be determined. The Specification method is too slow, however, for use in routine plant control. Several rapid but approximate methods of measuring moisture content are used for plant control; however, such methods must be checked frequently against the method required by Specifications.

Enzyme Inactivation

Certain naturally-occurring enzymes in fresh vegetable tissues must be inactivated prior to the drying operation to reduce deterioration of the dried product. In current practice, enzymes in fresh vegetables are inactivated when the cut commodity is blanched in live steam or hot water for a required period of time. Tests for residual enzyme activity in blanched material should be made frequently as a check on the completeness of the blanching operation.

Sulfite Content

Sulfite in dehydrated fruits and in some dehydrated vegetables helps prevent browning and loss of natural flavor and color. The dried products are not palatable, however, if too much sulfite is present. Sulfited materials tend to lose sulfite during drying. Commodities also may take up sulfite from combustion gases during the drying process. Careful control is necessary, therefore, to insure maintenance of proper sulfite levels in the finished product.

Oxygen in Gas-Packed Containers of Dehydrated Foods

Specifications require that some products be packaged in metal containers in an atmosphere of inert gas. The purpose is to minimize oxidative spoilage of the product by oxygen which would normally be present in the container. Samples of the packaged product must be taken at intervals and tested to determine the effectiveness of the gas-packing operation.

Reconstitution

The method of testing for reconstitution of each of the various dehydrated products is outlined in the appropriate Specification. In general, the method simulates the manner in which the product is most commonly used. In addition to being checked for its ability to take up water and return to its original size and shape, the reconstituted product is tested for flavor, odor, texture, and color.

390. Miscellaneous Plant Services

A. Lunch room

Good employee relations will be better assured if a satisfactory eating place is provided.

B. Chemicals

The chief chemicals used in dehydration plants are caustic soda and sulfite, carbon dioxide or nitrogen gas for packaging, chorine gas or solid hypochlorites used in connection with plant sanitation, and miscellaneous cleaning compounds. A separate storage space for chemicals is desirable; the main storage requirement is that the space must be kept dry.

Caustic soda (lye or sodium hydroxide) may be purchased in dry or liquid form. Many plants are now using liquid caustic and have only a standby supply of dry caustic in case delivery of the liquid material is delayed. Liquid caustic (usually 50% concentration) is delivered in tank cars or trucks and is pumped into storage tanks. This is diluted according to the peeling requirement of the particular commodity. Some concentrations of liquid lye will solidify at room temperatures, and provision must be made to convert it to liquid by heating it prior to use.

C. Sale of trimmings, fines, etc.

Some solid wastes, such as cabbage leaves and cores, sweetpotato trimmings, etc., should have demand as cattle feed. Farmers might haul this material away at no cost to the dehydrator. It is conceivable, in a feed shortage area, that some return might be had for this material.

Solid wastes, such as onion and beet skins, peels from lye-peeled vegetables, etc., may have no feed value and may have to be hauled away at some cost to the dehydrator.

Rejects from final inspection may have some value as stock feed. The fines screened out prior to packaging are just as nutritious as the acceptable finished product; a market may exist, therefore, for the sale of these fines to make soup stock, flavoring materials, and other food items. Some provision must be made to put the fines into containers for shipment or storage.

Plant Layout

It would appear from the many different layouts that have been used in various food processing plants that almost any type of layout will work. Just how well each works, though, is the important consideration. The differences in operating efficiency due to differences in plant layout have a large effect on processing costs.

There are several important points that should be considered in the design of a plant:

1) Sufficient room should be provided for each person, machine, and operation, so that they can function freely without being hampered by lack of space. Workers along an inspection or trimming belt should have ample space for movement to do the required job. For equipment, it is important to provide accessibility and sufficient space for workmen to repair or maintain the machines. A processing step should not be confined to an unduly limited area because additional equipment or facilities may be needed to overcome an unforeseen difficulty.

2) Straight-through operation is preferred. Cross-flow may be permitted if such condition does not hamper operations. Probably the most serious problems arise from the movement of workers and such equipment items as lift-trucks. The plant and equipment should be laid out so as not to obstruct normal plant traffic.

3) The various functions and facilities in a plant should be located conveniently to related functions. Several examples may be cited. The steam boiler should be located as near as feasible to point of greatest steam usage. The shop should be convenient to equipment that will require repair, to receiving or shipping areas for the handling of equipment and supplies, and to open or unobstructed areas in which items of equipment can be placed for repair. The laboratory should be convenient to the points in the processing line from which samples are drawn. The rest rooms, drinking fountains, and refreshment bars should be convenient to the greatest concentration of workers. Packaging supplies should be stored adjacent to the packaging room; raw commodity should be stored in close proximity to the feeding point of the preparation line.

4) The premises of the processing plant should be free from conditions objectionable to food processing operations, such as offensive odors, litter, waste, refuse, and dusty road approaches, yards, and parking lots. There should be no poorly drained areas within the immediate vicinity of the premises. Where obnoxious odors are involved, direction of prevailing winds must be considered in the plant arrangement.

5) Building and grounds should be planned to provide for expansion if needed. Expansion of a particular function, drying for example, should be possible without the necessity of rearranging or disturbing other functions. Locating the important functions on the perimeter of the building is one way of achieving this desired goal.

6) Adequate facilities such as rest rooms, locker rooms, and lunch rooms should be provided for employees. Operating areas of the building should not be cluttered with coats and lunches as would probably be the case if locker rooms or space were not provided. In order to avoid delay in having employees return to work, rest room and lunch room facilities should be sufficient to handle quickly all employees likely to use these facilities at any one time. Hot and cold water should be available in rest rooms. In some cases, shower rooms should be provided for plant personnel.

7) Adequate lighting, heating, and ventilation are imperative to assure that labor functions efficiently. Good, non-glare lighting is required, particularly for operations involving trimming and inspecting.

8) In some cases it may not be feasible to locate all parts of the plant within the limits of one building. Boiler rooms and sewage separation units can be conveniently located in small adjacent buildings or in an extension of the main building. Rooms -- such as the office, laboratory, and rest rooms -- not requiring over 8 or 9 foot ceilings might be located outside the main building.

9) Provision must be made to permit employees to cross long preparation lines so they will not have to traverse the entire length of the line. Two methods are commonly used: (a) passageways under elevators or elevated equipment, and (b) stairs or bridges over conveyor belts, etc.

Building Requirements

The type of building provided will be influenced by the climatic conditions of the area, the physical characteristics of the plant site chosen, and the local building codes and ordinances. These factors are difficult to appraise in advance and must be left to the prospective operator to evaluate for his particular situation. Certain basic points, however, will apply to all buildings wherever located.

It is desirable to plan a well-constructed, general-purpose building rather than one which solely meets the requirements of a specialized dehydration plant. In the event the dehydration operation is not continued either during or after the emergency period, the building would have a value for other purposes.

A rectangular building is generally useful and adaptable for other needs. Good typical wall construction might be concrete, cinder, or pumice block, reinforced as necessary, or wooden frame covered with sheet metal or asbestos board. The roof should be constructed so that the processing and storing areas are not unduly broken by supporting columns. Fire walls, fire doors, and emergency exits should be provided. An inside clearance of 14 feet normally will be sufficient except in product storage areas which should have higher clearances.

Floor of the building should be concrete throughout and provided with proper drainage gutters recessed into the floor. Many food processing plants have raised floors, at a level even with the beds of railroad cars and trucks. However, lift-trucks permit ground-level floors to be used at a considerable savings in building cost.

CHAPTER XII

GENERAL OPERATING CONSIDERATIONS

The operation of a dehydration plant during an emergency will confront the management with problems not likely to occur in peace time. These problems, plus usual operating problems, must be carefully appraised during planning and construction stages in order to assure a reasonably successful operation.

Raw Commodity Conservation

With increased demands upon the farmer during an emergency, waste of raw material produced by him should be held at a minimum. The plant should process the raw commodity in such a manner that the greatest quantities of acceptable dried product are produced. It is the responsibility of the operator to keep over-all shrinkage ratios as low as possible. He must apply the most effective techniques to his procedures and keep informed of the latest process developments and equipment used.

Careful selection of the best variety of raw commodity for dehydration, proper control of growing and harvesting conditions, selection of proper size, shape, and grade of raw commodities, and provision for suitable storage conditions are essential to assure maximum yield and quality of finished product.

The raw commodities should be received and processed in an orderly and uniform manner to assure highest finished product yields. If a larger than normal supply is received and held for an excessive period of time, high losses may be experienced.

Raw commodity received at the plant should be segregated and stored according to lot. Size of the lots may vary, depending partly on how much of the purchase is graded at each inspection. Thus, raw commodity of known characteristics may be processed together. It is sometimes necessary, however, to blend lots having different qualities in order to give an acceptable composite lot for satisfactory processing.

For root vegetables, it will be necessary to determine the best balance between peeling and trimming procedures. Need for trimming can be reduced by excessive peeling, but yield of finished product is thereby reduced. Care in trimming is important. A large saving in material can be accomplished when the trimmers are well trained and supervised. Plenty of "elbow room", adequate lighting, proper and well-maintained trimming tools, and a steady and adequate flow of product along the belt are all factors that help minimize trimming losses and increase efficiency.

Machines should be provided and operated in such a manner as to minimize waste as much as possible. Cutting machines produce a higher percentage of acceptable cut material when feed rate is within the desired range. Knives on cutting machinery

should be kept sharp. Use of dull knives results in pieces having irregular shape and lacking in well-defined cut surfaces. Furthermore, considerable bruising or tearing of tissues occurs which accelerates certain chemical processes leading to rapid deterioration of vitamin and other quality factors. Severe washing after cutting may cause excessive leaching.

Conservation of Labor

One of the most effective ways of reducing the need for labor is in the choice of a process and plant that are highly mechanized. Mechanized operations necessitate greater fixed capital investment and usually require more critical materials.

Construction of dehydration plants in larger sizes is another effective way of utilizing labor more efficiently. It is a general rule that output per employee increases as the size of plant increases.

Operations and equipment should be planned to use as many women as feasible, especially in the preparing and packaging operations. Use of light-weight units or use of automatic or semi-automatic equipment may make many tasks physically suited to women.

Effective supervision is one of the most important factors in labor saving. A training program should be carried out to develop supervisory personnel.

The piece-work method of pay has been used successfully in increasing output per employee. Quality of work performed sometimes suffers, however, so this method of pay must be carefully investigated before adoption and rigidly supervised if used.

Selection, Training, and Utilization of Personnel

A new dehydration plant is usually attended with discouraging results at first, at least until equipment has been tested and properly adjusted and employees have become proficient in their work. Some of the initial drawbacks can be minimized by employing personnel with previous experience in a similar plant. A nucleus of only a few experienced people at the start will greatly expedite getting a plant into successful operation.

Training employees is best accomplished by first explaining the specific task to be done (verbally, actual demonstration, etc.), and then having the individuals "learn by doing" under close supervision. Plant operations will be at a rather slow rate during any breaking-in period. It may be advisable to operate only one shift per day until equipment and processing steps have been tested and adjusted and a number of employees trained to help start other shifts. The rate of doing various operations should be gradually increased, as fast as testing and training permit, until full-scale operation is attained.

Considerable effort is necessary to make a smooth running, efficient organization. A part of this includes choosing supervisory personnel, establishing and posting responsibilities and wage scales for various positions, and developing teamwork. Periodic conferences should be held between supervisory personnel and management to discuss policies and to make improvements in operating techniques. Good employee morale is essential. There are many ways the management can help in maintaining good labor relations. Efficiency awards, such as are given by the Army, Navy, and other Governmental agencies to outstanding plants, are great morale boosters. Management should make every effort to earn such awards. Other ways of maintaining good labor relations include providing a fair means of settling misunderstandings, installing necessary safety devices, and rewarding good service. Suitable protective clothing should be provided, such as rubber gloves, hair nets, boots, etc. These are necessary for both employee protection and for product sanitation.

The day shift is under closer and more direct scrutiny of key personnel than the other two shifts. It is natural to expect that the day shift will be the best staffed and supervised. Night and swing shifts frequently operate short handed, mostly due to absenteeism, may have less laboratory and maintenance assistance, and usually receive least supervision.

Every effort should be made to care for the needs of each operating shift and to make each shift feel its importance to the enterprise. Production records of each shift and competition between different shifts should be encouraged to a certain degree. The competitive factor should not be over-emphasized, however, or product quality may suffer.

Operation of Equipment

Constant maintenance must be provided for all facilities. A competent maintenance man must make a periodic check and lubricate and adjust each piece of equipment as required.

Efficient plant operation requires frequent sharpening of cutting devices in mechanical dicers or slicers and hand knives used by trimmers. Drying trays should be kept in good repair. Trays that have broken slats or frames make tray handling difficult and slow, are more likely to leave splinters in final product, and may affect proper drying of the commodity by obstructing or short-circuiting flow of air. Conveyor and blancher belts must be kept in good condition. Tension on the belt should be adjusted to insure positive motion. Some types of wire-mesh belts have a tendency to stretch, thus requiring frequent adjustment of tension to give satisfactory operation.

In addition to physical maintenance of equipment, each critical processing operation must be checked and serviced by persons directly assigned to that function. Lye peelers,for example, should be frequently checked and adjustments made to maintain proper concentration of the lye solution, operating temperature, and peeling efficiency.

Operating Costs In New Plants

A new plant will experience higher operating costs than one that has operated successfully for more than one season. Items affecting cost that warrant the special attention of management are discussed briefly below:

1) Over-all shrinkage ratios. A new plant will most likely experience high shrinkage ratios until the best operating procedures have been determined and put into effect. Such things as excessive leaching losses, excessive peeling, trimming, coring and rooting, and excessive production of fines will lower yield of finished product. Improper drying and blanching techniques may cause production of discolored or otherwise unacceptable product. Procurement of improper quality raw commodity will adversely affect the shrinkage ratio.

2) Acceptance of finished product. Rejections likely will be high in the beginning stages of operation but should become negligible as the plant gains experience.

3) Output of product. While most operating costs are based on the wet-end of the process, output of finished product actually determines unit costs and profits. In addition to the factor of yield (over-all shrinkage ratio), output depends upon rate of production and time lost in shut-downs. New plants will experience a lower rate of production and will be plagued with more shutdowns than experienced plants. Costs will be affected accordingly.

4) Procurement of raw commodity. Personnel inexperienced in procuring and scheduling raw commodities and inexperienced growers usually will cause higher production costs. Both quality and quantity factors are involved. Even with the most careful scheduling, adverse weather conditions will affect delivery of the raw commodity, and the newcomer to this business will have difficulty in maintaining a smooth operating schedule.

5) Procurement of supplies and replacement of equipment. An emergency plant will in all likelihood obtain its various supplies and equipment under a priority system, and new plants in particular will have difficulties in getting delivery schedules of the needed items. Effective management policies and a capable purchasing agent can do much to minimize such contingencies.

6) Efficiency of labor. During learning and breaking-in periods labor costs will be higher but will decrease as the employees gain experience.

7) Labor rates. A new plant may have to pay higher labor rates because it offers little job security for employees. Many employees will work at lower rates for an established and permanent plant than for a new plant of doubtful life. A new plant offers better opportunity for advancement. It is probable that ceilings on rates of pay will be fixed, as in World War II, in an extended emergency. Movement of labor between jobs may also be restricted.

8) Plant maintenance and modification. Plant housekeeping costs may be high in new plants until processing procedures become routine matters. On the other hand, a new plant is easier to maintain in good condition than one which has deteriorated through use. Management of any new plant can therefore, expect to make some modifications in its original facilities before attaining efficient operation.

9) Utilities. Cost of utilities will be relatively high during first operating season until processing operations have been synchronized and personnel become experienced.

10) Insurance rates. New plants, having no record of successful performance and general plant care, will likely pay higher fire insurance rates. Furthermore, highly seasonal plants, and especially new ones, usually pay a higher unemployment insurance rate on labor.

11) Cost of plant. New plants built in high cost times will incur high capital charges such as depreciation. This may be offset by the installation of new and efficient processing equipment.

Lot Control

Output of finished product is usually divided into lots. Laboratory tests are made on each lot, and records kept accordingly. Packaged goods are stored and shipped according to lots. Military inspection of finished product will likely be by lot and acceptance and rejections made accordingly. Provision must be made, therefore, for testing, coding, and handling finished product by lots.

Several methods for establishing lots have been used. The most common system is to establish production of each shift, or portion of a shift, as a lot. Another method is to delegate authority to the laboratory to change lots in accordance with laboratory sample results. Still another method is based upon lot classification of the original raw commodity. Combinations of these methods may be useful.

Cost Control

High production costs may be tolerated only if it is impossible to fill the needs of Government for dehydrated foods at costs which are considered reasonable during normal times. In any case, costs should be only as high as absolutely necessary to produce the desired amount and kind of goods. Maintaining reasonable production costs in a time of high raw material costs, labor shortages, high labor rates, and equipment scarcities may be a most difficult task. This emphasizes the need for efficient operation, and in turn, an effective cost control.

A continuous record should be kept of the performance of the plant. This record can be subdivided by contract to show: (1) date bid was submitted and details of computations, (2) date accepted, (3) conditions and terms, (4) date contract was completed, (5) acceptability of product as proved by Government inspection tests, (6) record of monetary costs for each contract, (7) record of raw commodity used, (8) yields obtained, (9) important changes occurring during fulfillment of the contract, (10) other factors of importance concerning the contract itself. Analysis of this record will tell the operator the degree of his success in fulfilling his contract.

Apparently slight changes in raw commodity being processed can profoundly affect production costs. The major items that require continuous checking to control costs include the following:

1) Over-all shrinkage ratio

2) Production rate of finished product

3) Production per hour of labor

4) Percentage of finished product passing inspection

The first three items are greatly affected by quality of raw commodity used, and the last item is affected by practically all plant operations as well as raw commodity quality.

A daily cost summary should be made so that the production manager will have access to an analysis of the previous day's operations, and thus be in a position to make what changes are necessary to bring any excess cost item into line. It is not always feasible to measure each factor individually, but occasional checks should be made to determine limits of normal plant operation.

With a given input of raw commodity and number of workers, production rate is affected principally by factors involved in determining the shrinkage ratio. Production is also affected by weather conditions, by efficiency of dehydration equipment operations, and by factors affecting the trimming rate, such as physical defects and size (or size variation) in the raw material.

Trimming efficiency greatly affects operating costs because such a large part of total labor cost is involved in this operation. Trimming efficiency is determined partly by the nature of raw commodity, but frequently is affected sharply by the operation of peeling equipment. On root vegetables, excessive peeling can cut down trimming costs at the expense of yield. Studies should be made to determine the proper balance between degree of peeling and trimming.

Product passing Specifications should be maintained at or near 100%, but may fall below this figure, particularly in early stages of operation. At first glance this may appear to be purely a processing problem, but frequently the only cure for rejections is a tightening up in one or more of the plant operations and acceptance of the increased costs this involves. Cost analyses are necessary in these cases to determine how close to the line the operation in question can afford to run.

Labor saving studies offer a wide range of possibilities for reducing costs. Perhaps labor turnover is one of the biggest labor problems in a dehydration plant operating in an emergency period. Determination of costs of training new employees and effect of labor turnover on production rate are suggested types of analyses to make. Reports on causes of labor idleness, coupled with determination of possible remedies, present a valuable means of studying and effecting savings in labor. Comparisons of actual labor output with a suitable standard, studies of labor-saving devices and installations, and careful preparation of a labor budget, are all examples of controls that should be maintained on labor by the plant operator. Output per unit of labor is the chief criterion in judging labor efficiency.

Raw material control will consist mainly of maintenance and analyses of records containing information concerning relative advantages of different varieties, sizes, and grades of raw commodities -- showing preparation losses, drying ratios, yields of dried product from unprepared material, and processing costs of each batch of raw commodities. Analyses of the best handling methods should be included. Among the most important to consider are: (1) effects of storage, (2) effects of peeling procedures, (3) effects of various amounts of washing (especially on the cut material), and (4) studies of hand operation versus machine as related to yield of dry product. Records should be kept of weather conditions during the growing and harvesting of each lot of raw commodity processed. Analyses of these records form a basis upon which to judge future raw material purchases and to choose best times of planting and harvesting.

Cost Accounting for Vegetable and Fruit Dehydration Plants

Installation of a cost accounting system requires consideration of the operations involved and the information that is desired from the cost records. The cost accounting outline given herein is based upon the assumption that a plant handles only one commodity to produce one type of product. Collection and classification of costs is therefore somewhat simpler than where two or more products, or types of products, are produced. 1/

Certain main purposes have been considered in this accounting outline:

1) Ready calculation of total costs for producing the finished product, and determination of profit or loss resulting from production and sale of finished product

2) Comparison of costs for different lots or types of raw material

3) Comparison of costs of different methods for preparing, drying, and packaging

4) Assistance in controlling each operation and cost

5) Detailed records for reference and audit

Table VI gives a suggested account classification system. This system utilizes eight general controlling accounts:

1) Account series No. 100 - Raw Material Procurement

2) Account series No. 200 - Direct Labor (Manufacturing Operations)

1/ For a description of the problems involved and the methods of accounting when two or more end items are involved, see: (a) "Cost Accounting for the Canning Industry" (by Ralph H. Barr) in Handbook of Cost Accounting Methods, edited by J. K. Lasser, and published by D. Van Nostrand Co., Inc., New York, 1949; and (b) "Cost Accounting for Food Processors" by Wayne E. Mayhew, in National Association of Cost Accountants Bulletin, 28:647-68, Feb. 1, 1947.

3) Account series No. 300 - General Manufacturing Services

4) Account series No. 400 - Automotive Expenses

5) Account series No. 500 - Selling Expenses

6) Account series No. 600 - General and Administrative Expenses

7) Account series No. 700 - Total Cost of Finished Product

8) Account series No. 800 - Sales

The degree to which each general controlling account is subdivided into specific accounts will depend upon size and complexity of operation and amount of cost detail required. Many plants may find it desirable to subdivide the accounts still further than those indicated in Table VI. For example, "Preparing for Drying" (Account No. 220-230) may be divided to show individual items of cost such as peeling, trimming, blanching, etc.

Whether or not "General Manufacturing Services" (Account No. 300) and "General and Administrative Expense" (Account No. 600) are distributed among the various processing steps will depend upon degree of cost analysis desired. If only a determination of profit or loss is desired, no such distribution is necessary when only one end-product is manufactured. Should management wish an analysis of costs according to each operation, however, a distribution of these indirect costs must be made upon some equitable basis. Many distribution bases are in use. Suggested ways in which indirect costs can be distributed are shown in Table VII.

Compilation of costs by unit operation is valuable for determining relative costs of different plant operations and for evaluating alternative methods for doing a given operation.

A suggested classification for Balance Sheet Accounts, numbered from "00" to "99" is given in Table VIII.

TABLE VI

Descriptive Chart of Accounts for Vegetable or Fruit Dehydrating Plants

Account Number	Account	Explanation
100	Raw Material Procurement	
110	Purchase price	Amount paid to seller or broker for raw material
120	Buying expense	Buyers' salaries and expenses; brokerage; etc.
130	Field grading	Grading costs at field paid by dehydrator
140	Field packing	Crating and boxing costs at field paid by dehydrator
150	Transportation and weighing costs	Hauling costs of raw material; returning of empty containers; charges for weighing
160	Storage	For storage charges before delivery to dehydration plant
170	Containers	Labor and supplies for replacing and repairing containers
180	Federal and/or State inspection	Raw material inspection fees
190	Other raw material costs	Seed supplied by dehydrator; crop control costs paid by dehydrator
200	Direct Labor (Manufacturing Operations)	
210	Raw material handling in plant	Weighing at plant; unloading raw material; hauling material into plant storage; handling and washing empty crates or boxes; preliminary sorting and grading; hauling to preparation room.
220-230	Preparing for drying	Operating preparation equipment; peeling; trimming; sorting; coring; blanching; waste handling

(Continued)

TABLE VI (continued)

Account Number		Account	Explanation
	240	Drying	Operating dryers, including loading and unloading
	250	Product finishing	Operating screens; blending; removing defects from dried product
	260	Packaging and packing	Packaging, exhausting, and sealing; boxing and crating; labeling
	270	Warehousing	Trucking to warehouse; providing empty containers and boxes for filling; unloading packaging supplies from trucks or railroad cars
	290	Payroll taxes and insurance	For Social Security; Unemployment Insurance; Workmen's Compensation Insurance. These are direct labor costs and are charged to each operation on the basis of direct labor
300		Manufacturing Expenses	
	310	Indirect labor -- general	Superintendents, guards, and boiler operators, etc.
	320	Utilities	Water, fuel, electric power, sewage disposal
	330	Maintenance and repairs	Labor, parts, and supplies for repairing and maintaining plant and equipment
	340	Depreciation	Depreciation on factory building and equipment
	350	Taxes and insurance	Taxes and insurance on factory building and equipment
	360	Rentals and royalties	Rentals and royalties paid for use of equipment and processes
	370	Packaging and packing supplies and expenses	Packaging and packing supplies; freight and hauling of supplies; and other miscellaneous charges

(Continued)

TABLE VI (continued)

Account Number		Account	Explanation
	380	Inspection and control	Costs of operating own laboratory including salaries and expenses. Also fees paid to outsiders for inspection and testing
	390	Miscellaneous plant expenses	Lunch room expenses. Caustic soda and other chemicals used in plant
400		Automotive Expense	
500		Selling Expense	
	510	Salaries	Salaries of employees engaged in making up bids, selling, etc.
	520	Travel expenses	
	530	Brokerage and commissions	For goods sold other than to the Government
	540	Shipping labor and expenses	Loading trucks and railroad cars; cost of out-freight, etc.
	550	Miscellaneous supplies and expenses	
600		General and Administrative Expenses	
	610	Office salaries	General office management and clerical
	620	Travel expense	
	630	Utilities	Lights, heat, and telephone for general office
	640	Rental of general office	(if separate from plant)
	650	Interest expense	
	660	Taxes and insurance	Taxes and insurance on finished goods on hand will be charged to this account
	670	Association dues and assessments	

(Continued)

TABLE VI (continued)

Account Number		Account	Explanation
	680	Consulting services	Includes legal, accounting, technical, and other consulting services
	690	Miscellaneous supplies and expenses	
700		Total Cost of Finished Product	Charge with Raw Material Cost (Acct. 100); Direct Labor Cost (Acct. 200); Manufacturing Expenses (Acct. 300); and General and Administrative Expenses (Acct. 600)
800		Sales	
	810	Sales	Income from sales
	820	Sales returns, allowances, and rejects	Adjustment to sales

TABLE VII

Cost Summary Sheet to Indicate Product Cost and to Distribute Processing Costs Among the Various Operating Steps 1/

Cost Item	Total	Raw Material	Raw Material Handling	Preparing For Drying	Drying	Product Finishing	Packaging and Warehousing	Basis of Cost Distribution
Total Cost of Finished Product	Acct. 700							
Raw Material Procurement	Acct. 100	Acct. 100						
Direct Labor (Manufacturing Operations)	Acct. 200		Acct. 210	Acct. 220-230	Acct. 240	Acct. 250	Acct. 260) Acct. 270)	Daily time cards. Distribute Acct.290 on Basis of direct labor cost
Manufacturing Expenses	Acct. 300							
Indirect labor	Acct. 310							Direct labor
Utilities	Acct. 320							Use basis
Maintenance and repair	Acct. 330							Repair analysis
Depreciation	Acct. 340							Bldg. & equip. cost
Taxes and insurance	Acct. 350							Bldg. & equip. cost
Rentals and royalties	Acct. 360							Floor space for factory rental
Packing supplies and expenses	Acct. 370						Acct. 370	
Inspection and control	Acct. 380							Any equitable basis
Miscellaneous plant expenses	Acct. 390							Any equitable basis
General and Administrative Expenses	Acct. 600							No set basis. Use direct labor, processing cost, or other equitable basis.
Office salaries	Acct. 610							
Travel and other business expense	Acct. 620							
Utilities	Acct. 630							
Rental of general office	Acct. 640							
Interest expense	Acct. 650							
Taxes and insurance	Acct. 660							
Assoc. dues and assessments	Acct. 670							
Consulting services	Acct. 680							
Misc. supplies and expenses	Acct. 690							

1/ For a business organized solely for manufacturing and having no selling expense

TABLE VIII

Balance Sheet Accounts for Vegetable or Fruit Dehydrating Plants

ASSETS		LIABILITIES AND NET WORTH	
Account No.	Account	Account No.	Account
00	Current Assets	50	Current Liabilities
1	Cash	51	Accounts and Notes Payable
2	Accounts and Notes Receivable	52	Accrued Labor
3	Raw Material Inventory	53	Accrued Taxes
4	Goods in Process Inventory	54	Accrued Insurance
5	Finished Product Inventory	55	Interest Payable
6	Advances to Contract Growers	56	Advances from Government Procuring Agencies
7	Other Current Assets		
		60	Fixed Liabilities
10	Fixed Assets	61	Long Term Indebtedness
11	Land		
12	Sewage Equipment	70	Contingent Liabilities
12a	Reserve for Depreciation--Sewage Equipment	71	Reserve for Notes Receivable Discounted
13	Building		
13a	Reserve for Depreciation--Building	80	Deferred Credits and Reserves
14	Equipment and Facilities	81	Advance Payments Received on Contracts
14a	Reserve for Depreciation--Equipment and Facilities	82	Reserve for Spoiled or Rejected Product
15	Laboratory Equipment		
15a	Reserve for Depreciation--Laboratory Equipment	90	Net Worth
16	Office Equipment	91	Proprietor's Investment (Capital Stock)
16a	Reserve for Depreciation--Office Equipment	92	Earned Surplus
17	Automotive Equipment		
17a	Reserve for Depreciation--Automotive Equipment		
20	Deferred Charges and Prepaid Expenses		
21	Organization and Experimental Expense		
22	Prepaid Insurance and Taxes		
23	Manufacturing Supplies Inventory		
24	Fuel Inventory		
25	Office Supplies		
26	Laboratory Supplies		
27	Maintenance Parts and Supplies		
30	Investments		
40	Other Assets		

APPENDIX "A"

LIST OF APPLICABLE SPECIFICATIONS

Copies of Specifications, Standards, and Purchase Descriptions required by contractors in connection with specific procurement functions should be obtained by the contracting officer. Copies of Military and other non-military Specifications can be obtained from the Commanding General, Philadelphia Quartermaster Depot, 2800 South 20th Street, Philadelphia 45, Pennsylvania.

Product Specifications and Purchase Descriptions

Specifications	Number	Date
Apples, Dehydrated	Z-A-612a	9 Oct. 1957
Beans, Green, Dehydrated	MIL-B-35011	19 Dec. 1955
Beets, Dehydrated	MIL-B-3024	3 Aug. 1949
Cabbage, Dehydrated	MIL-C-826	27 July 1949
Carrots, Dehydrated	MIL-C-839	28 July 1949
Cranberries, Dehydrated	MIL-C-827A	4 Sept. 1951
Juice, Grapefruit, Dehydrated, (Powder)	Pur. Des.	2 Apr. 1956
Juice, Orange, Dehydrated, (Powder)	Pur. Des.	3 Apr. 1956
Onions, Dehydrated	JJJ-O-533	8 Aug. 1956
Peas, Green, Sweet, Dehydrated	Pur. Des.	1955
Potatoes, White, Dehydrated	MIL-P-1073A	12 Dec. 1950
Potatoes, Sweet, Dehydrated	MIL-P-3025 (1)	30 Nov. 1949

Supporting Specifications and Standards

Specifications	Number	Date
Beets, fresh	HHH-C-166c	16 Apr. 1956
Cabbage, fresh	HHH-C-266 (1)	13 Apr. 1954
Carrots, fresh	HHH-C-81c	30 Aug. 1955
Boxes, fiber	PPP-B-636	22 Apr. 1957
Boxes, wood, nailed, and lock-corner	PPP-B-621 (1)	25 Sept. 1957
Boxes, wood, wirebound	PPP-B-585 (1)	4 Apr. 1956
Boxes, wood, wirebound (overseas type)	MIL-B-107A (2)	18 Oct. 1952
Coatings, exterior, for tinned food cans	MIL-C-10506A (2)	23 Apr. 1953
Labeling of metal cans for subsistence items	MIL-L-1497B	2 Feb. 1945
Marking for shipment and storage	MIL-STD-129B (1)	18 Dec. 1957
Milk, dry; whole and nonfat solids	MIL-M-1495A (2)	22 Nov. 1954
Packaging and packing for overseas shipment boxes, fiberboard (V board and W board), exterior and interior	JAN-P-108 (5)	18 Oct. 1952
Paper; general specifications and methods of testing	UU-P-31b	3 Mar. 1949
Preservation, packaging and packing levels	FED-STD-No. 102	10 Jan 1957
Sampling procedures and tables for inspecting by attributes	MIL-STD-105A	11 Sept. 1950
Sampling for expensive testing by attributes (Appendix)	MIL-STD-105A	27 Apr. 1955
Tape, paper, gummed (sealing and securing)	UU-T-111b	23 Apr. 1951
Vegetables, dehydrated: packaging and packing of, with in-can dehydration	MIL-V-1378	12 Sept. 1949
Index of Specifications and Standards, Department of the Army	Volume II	1 Apr. 1958
Standards, U.S. Dept. of Agriculture		
Apples, dehydrated (low moisture)		29 Nov. 1955

APPENDIX "B"

PARTIAL LIST OF MANUFACTURERS OF VEGETABLE AND FRUIT DEHYDRATION EQUIPMENT

A partial list of names of equipment manufacturers is presented in the following table to assist prospective dehydrators in obtaining further information about equipment and processes. Inclusion in this table of the name of any manufacturer and the respective types of equipment manufactured does not imply a recommendation by the Department of Agriculture.

The names of companies listed were obtained from (a) Thomas Register of American Manufacturers, (b) Food Industries Classified Directory of Manufacturers, (c) manufacturers catalogs, (d) trade journals, (e) engineering firms, (f) equipment manufacturers, and (g) present dehydrators.

The table is divided into two parts:

A. Manufacturers of dryers

B. Manufacturers of equipment other than dryers

The table lists companies that make standard items of equipment specifically applicable to the various steps in processing and dehydrating vegetables and fruits. There are undoubtedly other companies that make such equipment but have not been included because the necessary information about their products was not available. Many of the firms listed can also fabricate or obtain and install other needed equipment suitable for a dehydration plant.

The table does not cover general equipment obtainable throughout the country. Such items include boilers, fans, heat exchangers, motors, pumps, scales, tanks, and trucks, and installations consisting of drying bins, material handling, refrigeration, water treatment, and waste disposal systems.

(A) PARTIAL LIST OF MANUFACTURERS OF DRYERS

NAME OF COMPANY	HOME OFFICE ADDRESS	BELT-TROUGH DRYERS	CONTINUOUS-BELT DRYERS	DRUM DRYERS	FLUIDIZED-BED DRYERS	PNEUMATIC CONVEYOR DRYERS	SHAKER-SCREEN DRYERS	TUNNEL DRYERS	VACUUM BELT DRYERS	VACUUM SHELF DRYERS
Artisan Metal Products, Inc.	Waltham, Mass.								X	
Bloxham Engineering Co.	Berkeley, Calif.							X		
Buflovak Equip. Div., Blaw Knox Co.	Buffalo, New York			X						X
Carrier Conveyor Corp.	Louisville, Ky.						X			
Chain Belt Co.	Milwaukee, Wis.								X	
Christian, J. D., Engineers	San Francisco, Calif.				X					
Combustion Engineering, Inc.	Chicago, Ill.					X				
Devine, J. P., Manufacturing Co., Inc.	Pittsburgh, Pa.			X						X
Diamond Manufacturing Co.	Oakland, Calif.	X								
Guardite Corporation	Chicago, Ill.									X
Guthier, E. H., Co.	Santa Ana, Calif.							X		
Idaho Falls Sheet Metal Works	Idaho Falls, Idaho				X	X	X			
Jeffrey Manufacturing Co., The	Columbus, Ohio						X			
Kathabar Div., Surface Combustion Corp.	Toledo, Ohio		X							
Knipschild Dehydrator Mfg. Co.	St. Helena, Calif.							X		
Link-Belt Company	Chicago, Ill.						X			
Miller, L. N., Dehydrator Co.	Eugene, Ore.							X		
National Research Corp.	Newton Highlands, Mass.								X	
Overton Machine Co.	Dowagiac, Mich.			X						
P & L Welding & Machine Works	Anaheim, Calif.					X				

(A) PARTIAL LIST OF MANUFACTURERS OF DRYERS

NAME OF COMPANY	HOME OFFICE ADDRESS	BELT-TROUGH DRYERS	CONTINUOUS-BELT DRYERS	DRUM DRYERS	FLUIDIZED-BED DRYERS	PNEUMATIC CONVEYOR DRYERS	SHAKER-SCREEN DRYERS	TUNNEL DRYERS	VACUUM BELT DRYERS	VACUUM SHELF DRYERS
Pfeiffer, John	San Jose, Calif.							X		
Proctor & Schwartz, Inc.	Philadelphia, Pa.		X							
Standard Steel Corp.	Los Angeles, Calif.			X						
Stokes, F. J., Machine Co.	Philadelphia, Pa.			X						X

(B) PARTIAL LIST OF MANUFACTURERS OF EQUIPMENT OTHER THAN DRYERS

NAME OF COMPANY	HOME OFFICE ADDRESS	BLANCHERS AND COOKERS	CONTROLLERS AND REGULATORS	CONVEYING, TRIMMING, AND INSPECTING BELTS	CUTTERS AND SHREDDERS	DEHUMIDIFIERS	HOMOGENIZERS AND COMMINUTERS	MASHERS AND RICERS	MIXERS AND BLENDERS	PACKING AND PACKAGING EQUIPMENT	PEELERS, CORERS, SNIPPERS, AND VINERS	SIZERS AND SORTERS	TRAY STACKERS AND SCRAPERS	WASHERS
Ajax Flexible Coupling Co.	Westfield, N. Y.			X								X		X
Allis Chalmers Mfg. Co.	Milwaukee, Wis.		X	X								X		X
Alvey Conveyor Mfg. Co.	St. Louis, Mo.			X										
American Can Company	New York, N. Y.									X				
American Machinery Corp.	Orlando, Fla.			X							X	X		X
Anstice Co., Inc.	Rochester, N. Y.				X						X	X		
Atlas-Pacific Engineering Co., Inc.	Emeryville, Calif.	X									X	X		
B-D-C Metal Co.	Everett, Mass.	X		X					X					X
Benner-Nauman, Inc.	Oakland, Calif.	X							X		X	X		X
Berlin Chapman Co.	Berlin, Wis.	X		X	X				X			X		X
Boutell Mfg. Co.	Rochester, N. Y.	X			X						X			
Bristol Company, The	Waterbury, Conn.		X											
Bryant Div. of Carrier Corp.	Indianapolis, Ind.					X								
Carrier Corporation	Syracuse, N. Y.					X								
Chisholm-Ryder Co., Inc.	Niagara Falls, N. Y.	X		X	X				X	X	X	X		X
Christian, J. D., Engineers	San Francisco, Calif.	X		X				X	X		X		X	X
Continental Can Co.	New York, N. Y.									X				
Dudley Machinery Corp.	Hollister, Calif.										X	X		
Dunkley Company	Kalamazoo, Mich.				X						X	X		
Eagle Machinery Co.	San Francisco, Calif.									X				

(B) PARTIAL LIST OF MANUFACTURERS OF EQUIPMENT OTHER THAN DRYERS

NAME OF COMPANY	HOME OFFICE ADDRESS	BLANCHERS AND COOKERS	CONTROLLERS AND REGULATORS	CONVEYING, TRIMMING, AND INSPECTING BELTS	CUTTERS AND SHREDDERS	DEHUMIDIFIERS	HOMOGENIZERS AND COMMINUTERS	MASHERS AND RICERS	MIXERS AND BLENDERS	PACKING AND PACKAGING EQUIPMENT	PEELERS, CORERS, SNIPPERS, AND VINERS	SIZERS AND SORTERS	TRAY STACKERS AND SCRAPERS	WASHERS
Electric Sorting Machine Co.	Houston, Texas											X		
Elliott Manufacturing Co.	Fresno, Calif.									X				
Fernholtz Machinery Co.	Los Angeles, Calif.								X			X		
Ferrell, A. T., & Co.	Saginaw, Mich.			X								X		X
Ferry, J. D., Co.	Harrisburg, Pa.			X	X						X	X		X
Fitzpatrick, W. J., & Co.	Chicago, Ill.				X									
Food Machinery & Chemical Corp.	San Jose, Calif.	X		X	X				X	X	X	X		X
Foxboro Company, The	Foxboro, Mass.		X											
Garbarino Machine & Iron Works	San Jose, Calif.												X	
General Slicing Machine Co.	Walden, N. Y.				X							X		
Greer, J. W., Co.	Cambridge, Mass.									X				
Gump, B. F., Co.	Chicago, Ill.			X					X					
Hamachek, Frank, Machine Co.	Kewaunee, Wis.				X						X			
Hayden Cranberry Separator Mfg. Co.	Wareham, Mass.				X							X		
Hobart Mfg. Co.	Troy, Ohio				X				X		X			
Horix Mfg. Co.	Pittsburgh, Pa.			X						X				X
Idaho Falls Sheet Metal Works.	Idaho Falls, Idaho	X		X	X			X	X		X	X		X
Idaho Sheet Metal Co.	Boise, Idaho	X							X		X			X
Jeffrey Mfg. Co., The	Columbus, Ohio	X		X	X							X		X
Mathabar Div., Surface Combustion Corp.	Toledo, Ohio					X								

(B) PARTIAL LIST OF MANUFACTURERS OF EQUIPMENT OTHER THAN DRYERS

NAME OF COMPANY	HOME OFFICE ADDRESS	BLANCHERS AND COOKERS	CONTROLLERS AND REGULATORS	CONVEYING, TRIMMING, AND INSPECTING BELTS	CUTTERS AND SHREDDERS	DEHUMIDIFIERS	HOMOGENIZERS AND COMMINUTERS	MASHERS AND RICERS	MIXERS AND BLENDERS	PACKING AND PACKAGING EQUIPMENT	PEELERS, CORERS, SNIPPERS, AND VINERS	SIZERS AND SORTERS	TRAY STACKERS AND SCRAPERS	WASHERS
Knipschild Dehydrator Co.	St. Helena, Calif.												X	
Langsenkamp, F. H., Co.	Indianapolis, Ind.	X		X	X				X		X	X		X
Leeds & Northrop Co.	Philadelphia, Pa.		X											
Link-Belt Co.	Chicago, Ill.			X								X		
Magnuson Engineering Co.	San Jose, Calif.				X						X			
Mathews Conveyor Co.	Ellwood City, Pa.			X										X
Minneapolis-Honeywell Regulator Co.	Philadelphia, Pa.		X											
Paramount Mfg. Co.	Stockton, Calif.			X								X		X
Patterson Foundry & Machine Co., The	East Liverpool, Ohio								X			X		X
Pfaudler Company, The	Rochester, N. Y.										X			X
Pfeiffer, John	San Jose, Calif												X	
Pittsburgh Lectrodryer Corp.	Pittsburgh, Pa.					X								
Rietz Manufacturing Co.	Santa Rosa, Calif.	X					X	X	X					
Robins, A. K., & Co., Inc.	Baltimore, Md.	X		X	X						X	X		X
Scott Viner Co., The	Columbus, Ohio	X			X							X		X
Sinclair-Scott Co.	Baltimore, Md.				X						X	X		X
Southwestern Engineering Co.	Los Angeles, Calif.											X		
Sprout, Waldron & Co., Inc.	Muncy, Pa.			X	X							X		
Stokes, F. J., Machine Co.	Philadelphia, Pa.									X				
Strong-Scott Mfg. Co.	Minneapolis, Minn.						X		X					

(B) PARTIAL LIST OF MANUFACTURERS OF EQUIPMENT OTHER THAN DRYERS

NAME OF COMPANY	HOME OFFICE ADDRESS	BLANCHERS AND COOKERS	CONTROLLERS AND REGULATORS	CONVEYING, TRIMMING, AND INSPECTING BELTS	CUTTERS AND SHREDDERS	DEHUMIDIFIERS	HOMOGENIZERS AND COMMINUTERS	MASHERS AND RICERS	MIXERS AND BLENDERS	PACKING AND PACKAGING EQUIPMENT	PEELERS, CORERS, SNIPPERS, AND VINERS	SIZERS AND SORTERS	TRAY STACKERS AND SCRAPERS	WASHERS
Sutton, Steele, & Steele, Inc.	Dallas, Texas											X		X
Syntron Corporation	Homer City, Pa.											X		
Taylor Instrument Co.	Rochester, N.Y.		X											
Urschel Laboratories, Inc.	Valparaiso, Ind.				X						X			

APPENDIX "C"

PARTIAL LIST OF SEED SUPPLIERS

Assistance and suggestions concerning production of the fresh commodities needed by a vegetable dehydration plant may be obtained from commercial seed companies. It is suggested that the prospective dehydrator confer with the companies listed below, or with any others in a position to serve the area being considered for a plant location.

Associated Seed Growers, Inc.
New Haven, Connecticut

Burpee, W. Atlee, Co.
Philadelphia, Pennsylvania

Burrell, D. V., Seed Growers Co.
Rocky Ford, Colorado

Charter Seed Co.
San Jose, California

Cooperative G. L. F. Exchange, Inc.
Buffalo, New York

Corneli Seed Co.
St. Louis, Missouri

Dessert Seed Co.
El Centro, California

Dickinson, Albert, Co.
Chicago, Illinois

Ferry-Morse Seed Co.
Detroit, Michigan

Gallatin Valley Seed Co.
Bozeman, Montana

Germain, Inc.
Los Angeles, California

McCullough's, J. Chas., Seed Co.
Cincinnati, Ohio

Northrup, King & Co.
Minneapolis, Minnesota

Peppard Seed Co.
Kansas City, Missouri

Peto Seed Co.
Saticoy, California

Pieters-Wheeler Seed Co.
Gilroy, California

Portland Seed Co.
Portland, Oregon

Roger Bros. Seed Co., Inc.
Idaho Falls, Idaho

Scarlett, William G., & Co.
Baltimore, Maryland

Seed Research Specialists, Inc.
Modesto, California

Washburn-Wilson Seed Co.
Moscow, Idaho

Woodruff, F. H., & Sons, Inc.
Milford, Connecticut

APPENDIX "D"

UNIVERSITIES, COLLEGES, EXPERIMENT STATIONS, AND EXTENSION SERVICES

It is suggested that the prospective dehydrator confer with the departments of horticulture, agronomy, food technology, chemistry, and chemical engineering of the universities and agricultural colleges in the State in which he proposes to locate a dehydration plant.

The various State agricultural colleges and experiment stations are listed in the table that follows. Information obtainable within the State may be augmented by references to other agricultural colleges and other universities that have given extensive study to dehydration technology, or have an especially strong background of dehydration knowledge and/or experience, such as University of California (Berkeley and Davis, California), University of Illinois (Urbana, Illinois), Oregon State College (Corvallis, Oregon), University of North Dakota (University Station, Grand Forks, North Dakota), and Massachusetts Institute of Technology (Cambridge, Massachusetts).

Land-Grant Colleges, Experiment Stations, and Extension Services 1/

State	Name and Location
Alabama	School of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the Alabama Polytechnic Institute (Auburn)
Alaska	Department of Agriculture of the University of Alaska and the Extension Service (College) and the Agricultural Experiment Station (Palmer)
Arizona	College of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of Arizona (Tucson)

1/ Source: U. S. Office of Experiment Stations. Workers in Subjects Pertaining to Agriculture in Land-Grant Colleges and Experiment Stations, 1957-58. Washington, D. C. 1958. (U. S. Department of Agriculture, Agriculture Handbook 15)

State	Name and Location
Arkansas	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Arkansas (Fayettville)
California	College of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of California (Berkeley)
Colorado	Colorado State University (with its Extension Administration) and the Agricultural Experiment Station (Fort Collins)
Connecticut	College of Agriculture (with its Extension Administration) and the Storrs Agricultural Experiment Station of the University of Connecticut (Storrs)
Delaware	School of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of Delaware (Newark)
Florida	College of Agriculture, Agricultural Experiment Station, and the Agricultural Extension Service of the University of Florida (Gainesville)
Georgia	College of Agriculture (with its Extension Administration) of the University of Georgia (Athens) Georgia Agricultural Experiment Station (Experiment)
Hawaii	Department of Agriculture of the University of Hawaii, the Agricultural Experiment Station, and the Agricultural Extension Service (Honolulu)
Idaho	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Idaho (Moscow)
Illinois	The College of Agriculture, the Agricultural Experiment Station, and the Extension Service in Agriculture of the University of Illinois (Urbana)
Indiana	School of Agriculture, the Agricultural Experiment Station, and the Department of Agriculture Extension of Purdue University (Lafayette)
Iowa	The Division of Agriculture, the Agricultural Experiment Station, and the Extension Service in Agriculture of the Iowa State College of Agriculture and Mechanic Arts (Ames)

State	Name and Location
Kansas	Kansas State College of Agriculture and Applied Science (with its Extension Administration) and the Agricultural Experiment Station (Manhattan)
Kentucky	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Kentucky (Lexington)
Louisiana	The Louisiana State University and Agricultural and Mechanical College, the Agricultural Experiment Station, and the Agricultural Extension Service (University Station, Baton Rouge 3)
Maine	College of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of Maine (Orono)
Maryland	College of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of Maryland (College Park)
Massachusetts	College of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of Massachusetts (Amherst)
Michigan	Michigan State University of Agriculture and Applied Science (with its Extension Administration) and the Agricultural Experiment Station (East Lansing)
Minnesota	College of Agriculture, the Agricultural Experiment Station, and the Division of Agricultural Extension of the University of Minnesota (St. Paul 1)
Mississippi	Mississippi State College (with its Extension Administration) and Agricultural Experiment Station (State College)
Missouri	Division of Agricultural Sciences, College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Missouri (Columbia)
Montana	Montana State College (with its Extension Administration) and the Agricultural Experiment Station (Bozeman)
Nebraska	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Nebraska (Lincoln)

State	Name and Location
Nevada	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Nevada (Reno)
New Hampshire	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of New Hampshire (Durham)
New Jersey	State College of Agriculture and Mechanic Arts (with its Extension Administration), and the Agricultural Experiment Station of Rutgers University (The State University), and the State Agricultural Experiment Station (New Brunswick)
New Mexico	School of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the New Mexico College of Agriculture and Mechanical Arts (State College)
New York	New York State College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of Cornell University (Ithaca)
	New York State Agricultural Experiment Station (Geneva)
North Carolina	North Carolina State College of Agriculture and Engineering (with its Extension Service) and the Agricultural Experiment Station of the University of North Carolina (Raleigh)
North Dakota	North Dakota Agricultural College (with its Extension Administration) and the Agricultural Experiment Station (State College Station, Fargo)
Ohio	The College of Agriculture (with its Extension Administration) of the Ohio State University (Columbus)
	Ohio Agricultural Experiment Station (Wooster)
Oklahoma	Oklahoma State University of Agriculture and Applied Science, the Agricultural Experiment Station, and the Agricultural Extension Service (Stillwater)
Oregon	School of Agriculture, the Agricultural Experiment Station, and the Federal Cooperative Extension Service of Oregon State College (Corvallis)
Pennsylvania	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the Pennsylvania State University (University Park)

State	Name and Location
Puerto Rico	College of Agriculture and Mechanic Arts (Mayagüez), the Agricultural Extension Service, and the Agricultural Experiment Station of the University of Puerto Rico (Rio Piedras)
Rhode Island	College of Agriculture, the Agricultural Experiment Station, and the Extension Service in Agriculture of the University of Rhode Island (Kingston)
South Carolina	Clemson Agricultural College (with its Extension Administration) and the Agricultural Experiment Station (Clemson)
South Dakota	South Dakota State College of Agriculture and Mechanic Arts (with its Extension Administration) and the Agricultural Experiment Station (College Station)
Tennessee	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Tennessee (Knoxville)
Texas	Agricultural and Mechanical College of Texas, the Agricultural Experiment Station, and the Agricultural Extension Service (College Station)
Utah	Utah State University, the Agricultural Experiment Station, and the Agricultural Extension Service (Logan)
Vermont	College of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the University of Vermont (Burlington)
Virginia	School of Agriculture, the Agricultural Experiment Station, and the Agricultural Extension Service of the Virginia Polytechnic Institute (Blaksburg)
Washington	State College of Washington, Agricultural Experiment Station, and the Agricultural Extension Service (Pullman)
West Virginia	College of Agriculture (with its Extension Administration) and Agricultural Experiment Station of West Virginia University (Morgantown)
Wisconsin	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Wisconsin (Madison)
Wyoming	College of Agriculture (with its Extension Administration) and the Agricultural Experiment Station of the University of Wyoming (Laramie)

APPENDIX "E"

GOVERNMENTAL AGENCIES

State Agencies:

A prospective dehydrator should consult with the various State departments concerned with agriculture and public health in the State he is considering for a plant location, and with various Federal agencies. Particular organizations which will be most helpful are those concerned with agricultural production statistics, horticulture, agronomy, food processing technology, and quality control of food products.

Federal Government Agencies:

Department of the Army

Quartermaster Food and Container Institute for the Armed Forces, 1849 W. Pershing Road, Chicago, Illinois

Department of Agriculture

Agricultural Research Service

a) Western Utilization Research and Development Division
Albany, California

b) Southern Utilization Research and Development Division
New Orleans, Louisiana

c) Eastern Utilization Research and Development Division
Philadelphia, Pennsylvania

d) Crops ~~Production~~ Research Division, Beltsville, Maryland

Agricultural Marketing Service

a) Agricultural Estimates Division (and Crop Reporting Board)
Washington 25, D. C.

b) Fruit and Vegetable Division
Washington 25, D. C.

c) Food Distribution Division
Washington 25, D. C.

d) Marketing Research Division
Washington 25, D. C.

Canadian Research Agencies:

Department of Agriculture

Experimental Farm Service
Ottawa, Ontario

Experimental Station
Experimental Farm Service
Summerland, British Columbia

Experimental Station
Experimental Farm Service
Kentville, Nova Scotia

Defence Research Board

Defence Research Medical Laboratories
Toronto 12, Ontario

APPENDIX "F"

PARTIAL LIST OF TRADE ASSOCIATIONS

The following partial list of trade associations is submitted as a suggested source of information concerning the processing of vegetables and fruits.

The names listed were obtained from (1) The Canning Trade Almanac (1957), (2) The Directory of National Trade Associations, U. S. Department of Commerce (1956), (3) The Western Canner and Packer Statistical Review and Yearbook (1958), and (4) other pertinent literature.

Professional organizations such as Institute of Food Technologists, 176 W. Adams Street, Chicago 3, Illinois, and American Chemical Society, 1155 16th Street N.W., Washington, D. C., are sources of information regarding potential technical employees.

American Dehydrated Onion and Garlic Assn.
33 Montgomery Street
San Francisco 4, California

American Seed Trade Association
30 N. La Salle Street
Chicago 2, Illinois

American Spice Trade Association
82 Wall Street
New York 5, New York

Associated Independent Canners
P. O. Box 1229
Madison, Wisconsin

California Processors & Growers, Inc.
Financial Center Building
Oakland, California

Canadian Food Processors Assn.
245-1/2 Bank Street
Ottawa, Ontario, Canada

Can Manufacturers Institute, Inc.
815 - 15th N. W.
Washington 5, D. C.

Canners League of California
215 Market Street
San Francisco 5, California

Canning Machinery & Supplies Assn.
4630 Montgomery Avenue
Washington 14, D. C.

Citrus Processors Association
P. O. Box 1459
Winter Haven, Florida

Dried Fruit Association of California
World Trade Center
San Francisco, California

Eastern Shore of Virginia Packers Assn.
Cape Charles, Virginia

Florida Canners Association
490 Third Street, N. W.
Winter Haven, Florida

Georgia Canners Association
P. O. Box 73
Griffin, Georgia

Illinois Canners Association
114-1/2 N. Monroe Street
Streator, Illinois

Indiana Canners Association
205 Carney Building
Shelbyville, Indiana

Institute of Sanitation Management
101 W. 30th Street
New York 1, New York

Iowa-Nebraska Canners Association
P. O. Box 483
Marshalltown, Iowa

Louisiana-Mississippi-Alabama
Vegetable Processors Association
c/o Southern Shell Fish Company
Harvey, Louisiana

Maine Canners & Freezers Association
c/o Snow Flake Canning Company
Brunswick, Maine

Michigan Canners and Freezers Assn.
1014 Franklin Street, S. E.
Grand Rapids 7, Michigan

Minnesota Canners and Freezers Assn.
303 Wesley Temple Building
Minneapolis 3, Minnesota

National Association of Frozen
Food Packers
1415 K Street, N. W.
Washington 5, D. C.

National Canners Association
1133 - 20th Street, N. W.
Washington 6, D. C.

National Cranberry Association
Hanson, Massachusetts

National Food Brokers Association
1916 M Street
Washington 6, D. C.

National Food Distributors Assn.
900 North Michigan Avenue
Chicago 11, Illinois

New Jersey Canners Association
c/o R. S. Watson & Son
Greenwich, New Jersey

New York State Canners and
Freezers Association
226 First Federal Savings Building
Rochester 4, New York

Northwest Canners & Freezers Assn.
Corbett Building
Portland 4, Oregon

Northwest Dried Fruit Association
1001 S. E. Water Avenue
Portland 14, Oregon

Ohio Canners Association
993 Kilbourne Drive
Worthington, Ohio

Ontario Food Processors Association
Ontario Food Terminal
Toronto, Canada

Ozark Canners Association
P. O. Box 91
Fayetteville, Arkansas

Packaging Machinery Manufacturers Institute
60 E. 42nd Street
New York 17, New York

Pennsylvania Canners Association
25 N. Duke Street
York, Pennsylvania

Processed Apple Institute, Inc.
30 E. 40th Street
New York 16, New York

Refrigeration Research Foundation
12 North Meade Avenue
Colorado Springs, Colorado

Research and Development Associates,
Food and Container Institute
1849 W. Pershing Road
Chicago 9, Illinois

Santa Clara County Canners Association
215 Market Street
San Francisco 5, California

Southern California Food Processors Assn.
649 S. Olive Street
Los Angeles 14, California

Southwest Canners Association
312 Meadows Building
Dallas 6, Texas

Tennessee-Kentucky Canners
c/o Tennessee Foods, Inc.
Portland, Tennessee

Texas Canners Association
P. O. Box 47
Weslaco, Texas

Tidewater Canners Assn. of Virginia
c/o Cople Canning Company
Kinsale, Virginia

Tri-State Packers Association
Easton, Maryland

Utah Canners Association
320 Kiesel Building
Ogden, Utah

Virginia Canners Association
1228 Third Street, S. W.
Roanoke, Virginia

Western Food Processors Association
355 Burrard Street
Vancouver 1, British Columbia

Western Frozen Food Processors Assn.
244 California Street
San Francisco 11, California

Western Growers Association
3091 Wilshire Boulevard
Los Angeles, California

Wisconsin Canners Association
1003 Tenney Building
Madison 3, Wisconsin

APPENDIX "G"

SELECTED LITERATURE REFERENCES

The references and suggested sources of information given herein cover principles and practices in dehydration and other information of primary interest in management groups contemplating entry into the dehydration field. The references, which are mainly from American sources, are classified under the following categories:

1. Directories
2. Books, Pamphlets, and Bulletins
3. Periodicals
4. References from Journals

Directories

Food Products Directory Issued by Miller-Freeman Publications, San Francisco. Classified according to products and includes section on dehydrated items.

National Dehydrators Assoc. Classified Directory of United States and Canadian Dehydrated Food Processors (exclusive of milk driers), Distributors, Equipment Manufacturers, and Packaging Material Manufacturers, etc., and Their Products. 3rd ed. Washington, D.C., The Assoc., 1945. 47 p.

Thomas' Wholesale Grocery and Kindred Trades Register. Regularly revised and issued by the Thomas Pub.Co., New York. Includes section on dehydrated fruits and vegetables, list of produce dealers, brokers, and wholesalers. Classified according to products (including a section on dehydration), trade names, and manufacturers, dealers, brokers, and wholesalers.

Thomas' Register of American Manufacturers. Revised and published yearly by the Thomas Publishing Co., New York. Manufacturers classified according to type of items manufactured.

Books, Pamphlets, and Bulletins

U.S. Army. Quartermaster Corps. Food and Container Institute, Research and Engineering Command. Numerous project reports on contracts for experimental work done for the Quartermaster General by various research organizations throughout the country.

1958

U.S. Agricultural Marketing Service. Regulations Governing the Inspection and Certification of Processed Fruits and Vegetables and Related Products. Washington, D.C., 1958. 13 p. (U.S. Agricultural Marketing Service, SRA-AMS 155, revised Aug. 1958)

1957

Davis, G. N. Onion Production in California. (Berkeley) 1957. 26 p. (California Experiment Station, Manual 22)

Dwoskin, P.B., and Jacobs, Milton. Potato Flakes--A New Form of Dehydrated Mashed Potatoes: Market Position and Consumer Acceptance in Binghamton, Endicott, and Johnson City, New York. Washington, D.C. 1957. 54 p. (U.S. Agricultural Marketing Service, Marketing Research Report 186) Market testing by the Market Development Branch of the Marketing Research Division of a product developed by the Eastern Utilization Research and Development Division of the Agricultural Research Service.

U.S. Agricultural Marketing Service. Regulations Governing the Inspection and Certification of Fresh Fruits and Vegetables, and Other Products. (Title 7, Ch.I, Pt.51 of the Code of Federal Regulations) Washington, D.C., 1957. 14 p. (U.S. Agricultural Marketing Service, SRA-AMS-93, revised Jan. 1957)

1956

Cording James, Jr., Eskew, R.K., and others. Potato Flakes: A New Form of Dehydrated Mashed Potatoes. Issued in parts: I. Pilot Plant Process Using Double Drum Drier; II. Some Factors Influencing Textures; and III. Estimated Commercial Cost. Philadelphia, Pa., 1954-56. 5, 8, 15 p. (U.S. Agricultural Research Service. ARS-73-2, ARS-73-9, and ARS-73-12 respectively.)

1955

Kilpatrick, P.W., Lowe, Edison; and Van Arsdel, W.B. "Tunnel dehydrators for fruits and vegetables." pp.313-72 of Advances in Food Research Vol. 4, 1955.

von Loesecke, H.W. Drying and Dehydration of Foods. 2d ed. New York, Reinhold, 1955. 300 p. Fairly complete summary of industry practices, plus valuable bibliographies.

1954

Boswell, V.R. Commercial Growing of Carrots Washington, D.C., 1954. 8 p. (U.S. Department of Agriculture Leaflet 353)

Cockerham, K.L., and others. The Sweetpotato Weevil and How to Control It. Washington, D.C., 1954. 7 p. (U.S. Department of Agriculture Leaflet 121)

Gray, R.W.; Sorenson, V.L.; and Cochrane, W.W. An Economic Analysis of the Impact of Government Programs on the Potato Industry of the United States. St. Paul, 1954. 239 p. (Minnesota Agricultural Experiment Station. Technical Billetin 211) (North Central Regional Publication 42) Notes a trend toward specialization in potato production.

Hendel, C.E., and Burr, H.K. In-package Desiccation of Dehydrated Foods. Albany, California, 1954. 14 p. (U.S. Bureau of Agricultural and Industrial Chemistry. AIC-373)

Wright, R.C.; Rose, D.H.; and Whiteman, T.M. The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks. Washington, D.C., 1954. 77 p. (U.S. Department of Agriculture, Agricultural Handbook 66) Definitive compilation plus extensive bibliography.

1953

Cook, A.C. Highlights of Potato Marketing. Washington, D.C., 1953. 56 p. (U.S. Department of Agriculture, Agriculture Information Bulletin 114)

Lambeth, V.N. Sweet Potato Production in Missouri. Columbus, 1953. 24 p. (Missouri Agricultural Experiment Station, Bulletin 600)

Park, J.K.; Powers, M.R.; and Garrison, O.B. Machinery for Growing and Harvesting Sweet Potatoes. Clemson, 1953. 35 p. (South Carolina Agricultural Experiment Station, Bulletin 404)

Peery, D.L. Production Practices in Growing Sweet Potatoes in the Coastal Plains Area of South Carolina. Clemson, 1953. 35 p. (South Carolina Agricultural Agricultural Experiment Station, Bulletin 407)

Rasmussen, C.L.; and Shaw, W.L. Preliminary Planning for Vegetable Dehydration. Albany, Calif., 1953. 26 p. (U.S. Bureau of Agricultural and Industrial Chemistry, AIC-356)

Shoemaker, J.S. Vegetable Growing. 2d ed. New York, Wiley, 1953. 515 p. A general text like those by J.E. Knott (1949) and by H.C. Thompson (1949).

Sparks, W.C. Storing the Idaho Potato. Moscow, 1953, 15 p. (Idaho Agricultural Experiment Station, Bulletin 296)

Whitehead, Tatham; McIntosh, T.P.; and Findlay, W.M. The Potato in Health and Disease. 3d ed. Edinburgh, Oliver and Boyd, 1953. 744 p.

1952

Association of Food Industry Sanitarians, Inc. Sanitation for the Food-Preservation Industries. New York, McGraw-Hill, 1952. 284 p.

Idaho Agricultural Experiment Station. Producing the Idaho Potato. Moscow, 1952, 16 p. (Station Mimeo Leaflet 121)

Olson, R.L. Sanitation and Microbiology as Related to Vegetable Dehydration. Albany, Calif., 1952. 14 p. (U.S. Bureau of Agricultural and Industrial Chemistry, AIC-344)

Union Pacific Railroad. Agricultural Development Department. Handling Onions. Rev.ed. Omaha, 1952. 15 p.

1951

Allen, F.W. Apple Growing in California. Berkeley, 1951. v.p. (California Agricultural Extension Service, Circular 178)

American Potato Yearbook (annual) Westfield, N.J. McFarland Publications, 1951 -

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APPENDIX "H"

CODE FOR CLASSIFYING MATERIALS, OPERATING STEPS, AND FACILITIES

This classification code has been adopted for simplifying and unifying discussion in presenting information concerning operations and equipment. This code is based primarily upon the cost accounting system presented in Chapter XII, "General Operating Considerations".

This basic classification code is applicable to all types of dehydration plants necessary to process the commodities considered in this Handbook, although a particular plant may not require use of the entire classification system.

Classification Code

100. RAW MATERIAL PROCUREMENT

    110. Purchase Price

    120. Buying Expense

    130. Field Grading

    140. Field Packing

    150. Transportation and Weighing Costs

    160. Storage

    170. Containers

    180. Federal and/or State Inspection

    190. Other Raw Material Costs

200. MANUFACTURING OPERATIONS 1/

210. Raw Material Handling in Plant

220-230. Preparing for Drying

240. Drying

250. Product Finishing

260. Packaging and Packing

270. Warehousing and Shipping

300. GENERAL MANUFACTURING SERVICES

310. Indirect Labor - General

320. Utilities

330. Maintenance and Repairs

340. Depreciation

350. Taxes and Insurance

360. Rentals and Royalties

370. Packaging and Packing Supplies and Expenses

380. Inspection and Control

390. Miscellaneous Plant Services

1/ Further breakdown varies with the commodity.

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